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Energy Audit Final Report

Town of Essex
Town Hall
29 West Avenue
Essex, CT 06426

Project Number: ESSEX1A



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EXECUTIVE SUMMARY

Through a Municipal Energy Efficiency and Conservation Block Grant funded under the American Recovery and Reinvestment Act of 2009, the Town of Essex, CT solicited services for an energy audit and assessment of the Town Hall. The project was awarded to Steven Winter Associates, Inc. (SWA) on April 29, 2010 and the site assessment was conducted on May 13, 2010. This audit was funded, in part, by a planning grant from the Connecticut Trust for Historic Preservation.

Located at 29 West Avenue, the Essex Town Hall is a three-story historic building originally built in 1892. The building is approximately 24,000 ft² and houses town offices, a conference room, the Resident State Trooper's office, and a public assembly space. Between August 2008 and July 2009, electrical consumption totaled 138,960 kWh at a cost of \$25,866 or \$0.186/kWh. For that same period, total fuel oil consumption for the building was 6,961 gallons at a total cost of \$20,148 or \$2.894/gallon. With electricity and oil consumption combined, the building used 1,449 MMBtu of energy at a total estimated cost of \$46,014 during this time period.

The following building assessment report summarizes the findings and recommendations of the building audit. The recommended energy and water conservation measures are summarized in the Proposed Scope of Work shown in the table on the following page. Estimated utility and associated cost savings are provided for each measure that will result in a reduction of heating, cooling, and/or electric usage. Pricing information for the measures is provided whenever possible.

Energy data collected in the field was imported into eQuest energy conservation software to generate a baseline energy model of the building. SWA simulated the installation of energy improvement measures against the modeled baseline to create a projected model. Energy saving calculations and projected economics were utilized to support the conclusions.

SWA also entered energy information about the Essex Town Hall into the U.S. Environmental Protection Agency's (EPA) *ENERGY STAR® Portfolio Manager* energy benchmarking system. This primarily office space is also comprised of non-eligible ("Other") space types. As a result, it cannot be directly compared to similar office buildings to obtain a performance score. However, this tool can be used by Essex staff to continue to assess the building performance over time and identify the energy intensity relative to other municipal facilities.

The goal of this energy audit is to provide information to support decision-making related to the implementation of appropriate and cost effective energy efficiency measures for the building. SWA has separated the investment opportunities into four categories of recommendations:

1. Capital Improvements – Upgrades not directly associated with energy savings
2. Operations and Maintenance – Low Cost/No Cost Measures
3. Water Conservation Measures – Methods to reduce water and associated energy usage
4. Energy Conservation Measures – Higher cost upgrades with associated energy savings

SWA has provided recommendations in all four categories and is recommending the first 4 of the 6 analyzed Energy Conservation Measures (ECMs) for this facility. The total investment cost for these ECMs is **\$19,827**. SWA estimates a first year savings of **\$4,154** with a simple payback of **4.8** years. See the Findings and Recommendations section for further details.

Essex has received a Community Innovation Grant through the Connecticut Clean Energy Fund and may also be eligible for renewable energy incentives and educational support. The building may qualify for utility incentives and/or low-interest loans through the Connecticut Energy Efficiency Fund (CEEF) for electric energy efficiency upgrades. The building utilizes window units and does not have a central air conditioning system. Since the building is heated using fuel oil, utility incentives may be prorated based on the electrical portion of the anticipated energy savings. Please contact CEEF for program details and eligibility.

Proposed Scope of Work

Based on the assessment of this building, SWA has separated the investment opportunities into four categories of recommendations. A more detailed description is provided in the Findings and Recommendations section of this report

Category I Recommendations: Capital Improvements

- Roof Replacement
- Boiler Replacement

Category II Recommendations: Operations and Maintenance

- Weather Stripping/Air Sealing
- Pipe Insulation
- Energy Star Appliances/Plug Loads
- Public Assembly Ventilation Requirements
- Programmable Thermostats

Category III Recommendations: Water Conservation Measures (WCMs)

- Water Efficient Fixtures & Controls

Category IV Recommendations: Energy Conservation Measures (ECMs)

ECM#	Description of Energy Conservation Measures
1	Lighting Upgrades: See Appendix B
2	Boiler Outdoor Temperature Reset Controls
3	Ceiling Insulation and Air Sealing
4	Install Vending Miser
5	Window Replacement
6	Install 20 kW PV rooftop system

INTRODUCTION

Steven Winter Associates, Inc. (SWA) is a 38-year-old architectural/engineering research and consulting firm, with specialized expertise in green technologies and procedures that improve the safety, performance, and cost effectiveness of buildings. SWA has a long-standing commitment to creating energy-efficient, cost-saving and resource-conserving buildings. As consultants on the built environment, SWA works closely with architects, developers, builders, and local, state, and federal agencies to develop and apply sustainable, 'whole building' strategies in a wide variety of building types: commercial, residential, educational and institutional.

SWA performed an energy audit and assessment for the Essex Town Hall at 29 West Avenue in Essex, Connecticut. The process of the audit included facility visits on March 11 and May 13, 2010. The scope of this assessment includes benchmarking and energy bill analysis, assessment of existing conditions, energy modeling, and recommendations for energy conservation measures and other improvements.

This report provides a summary of current building conditions, current operating costs, potential savings, and investment costs to achieve these savings. The facility description includes energy usage, occupancy profiles, and current building systems, along with a detailed inventory of building energy systems and recommendations for improvement.

The goal of this Energy Audit is to provide sufficient information to the Town Hall to make decisions regarding the implementation of the most appropriate and most cost-effective energy conservation measures for the building.

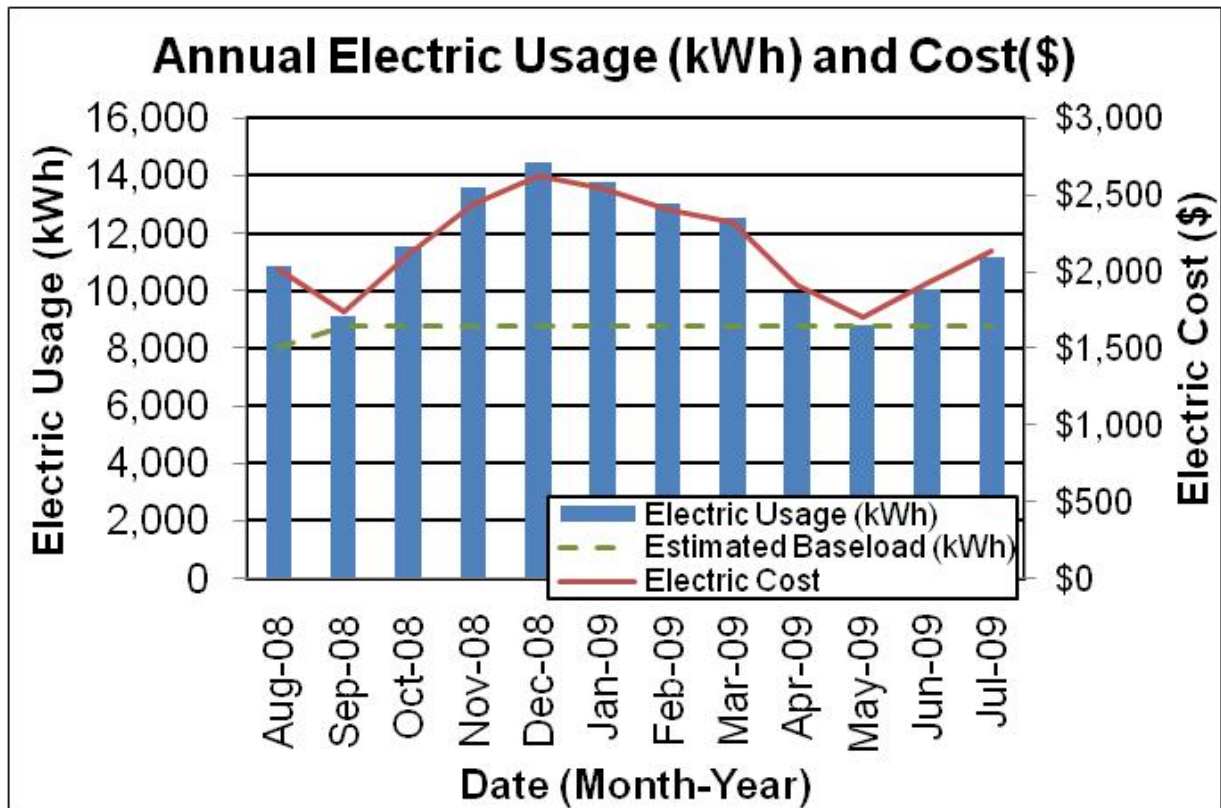
HISTORICAL ENERGY CONSUMPTION

Energy usage, load profile and cost analysis

SWA reviewed utility bills for the most recent 12 month period of utility data collected, August 2008 through July 2009. This analysis was used for all calculations and for purposes of benchmarking the building. With electricity and oil consumption combined, the building used 1,449 MMBtu of energy at a total estimated cost of \$46,014 during this time period.

Electricity - The Town Hall is currently served by one electric meter. The Town Hall buys electricity from Connecticut Light & Power (CL&P) at **an average aggregated rate of \$0.186/kWh**. For the most recent 12 month period of utility data collected, electrical consumption totaled approximately **138,960 kWh** at a cost of **\$25,866**. The average monthly demand was **32 kW** and the annual peak demand was 34.8 kW.

The chart below shows the monthly electric usage and costs. The dashed green line represents the approximate baseload or minimum electric usage required to operate the Town Hall.

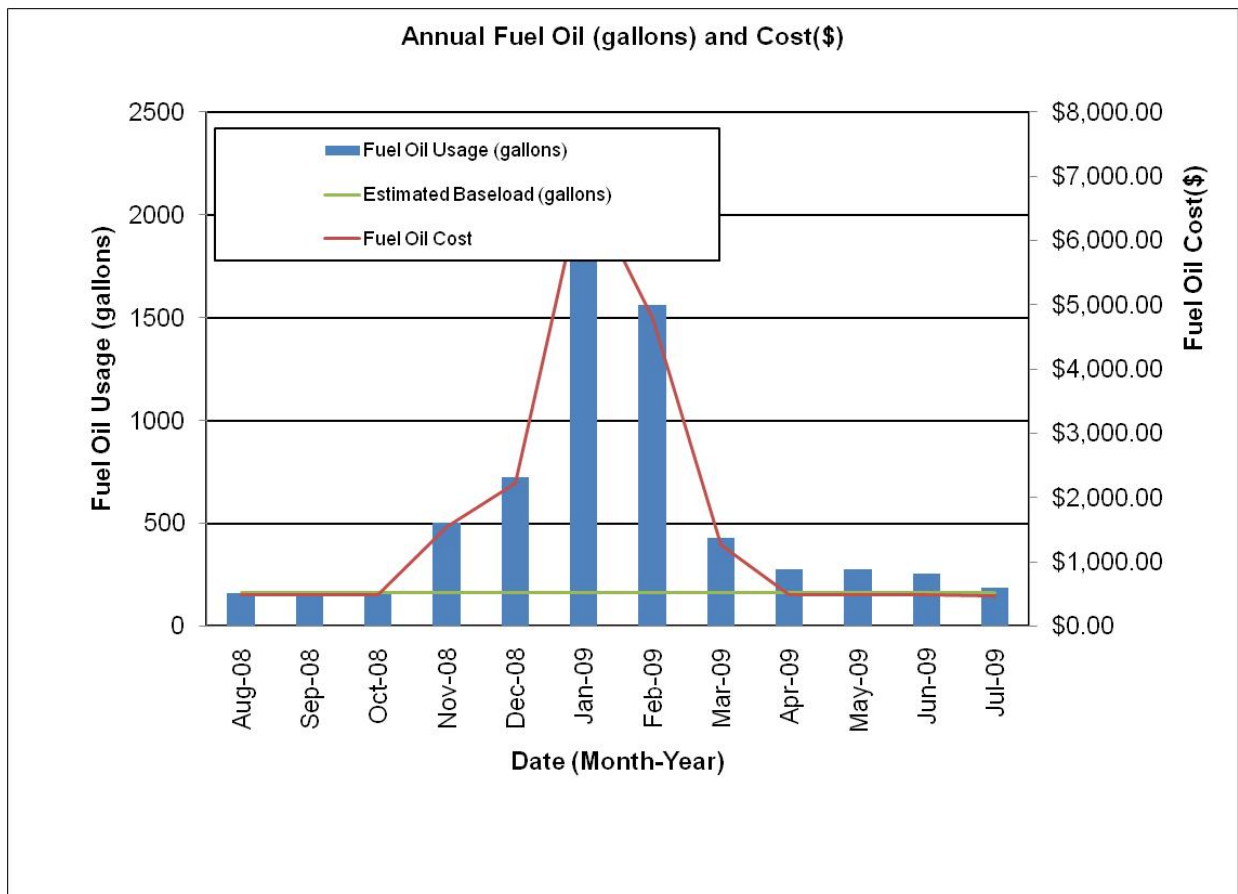


Fuel Oil - The Town Hall utilizes #2 Fuel Oil for both heating and domestic hot water generation. In addition, there is an oil-fired electric generator on-site that provides back-up power to the entire facility. The Town Hall currently procures oil through East River Energy. For the analysis period, oil was purchased at **an average aggregated rate of \$2.89/gallon**. The Town Hall purchased **6,961 gallons** of oil at a total cost of **\$20,148**. For the purposes of this report, the Town requested an average oil cost of **\$2.50/gallon** be used for the payback analysis.

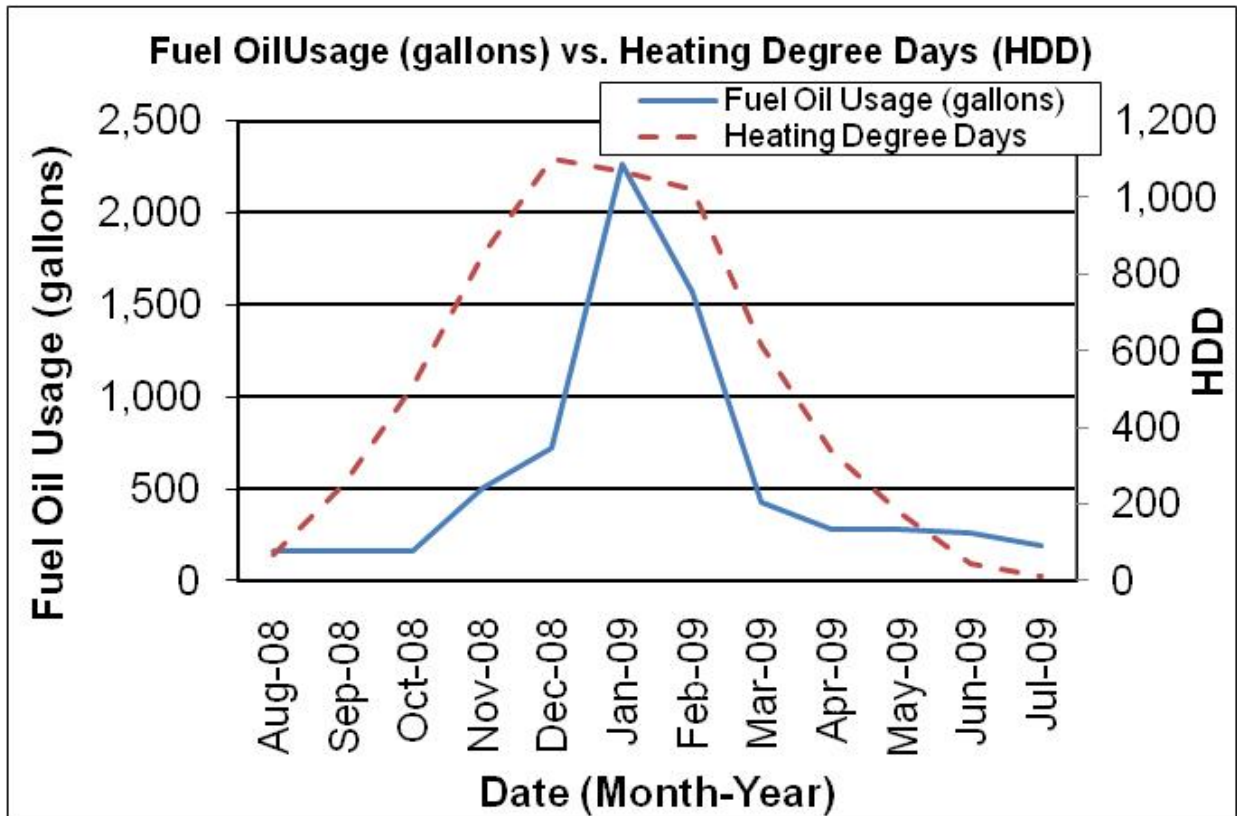
The fuel oil price typically fluctuates during the heating season, with the actual winter rates exceeding the assumed average. Thus, the savings associated with heating recommendations in this report are conservative with respect to the actual winter rates that exceed \$3.00/gallon.

The chart below shows an estimated monthly fuel oil profile based on assumptions for heating consumption and heating degree days. Since oil deliveries are not always done on a monthly schedule, this information has been extrapolated using engineering assumptions and best practice calculations. The green line represents the approximate baseload or summer oil usage required for domestic hot water and operation of the oil-fired back-up generator.

It is SWA's understanding that this building participates in an electrical Demand Response Program, which utilizes the back-up generator to supply electricity for the building during periods of peak electrical demand. Thus, the baseload shown below includes oil-fired power generation for both operation of the building and routine exercising of the equipment, as well as domestic hot water generation.



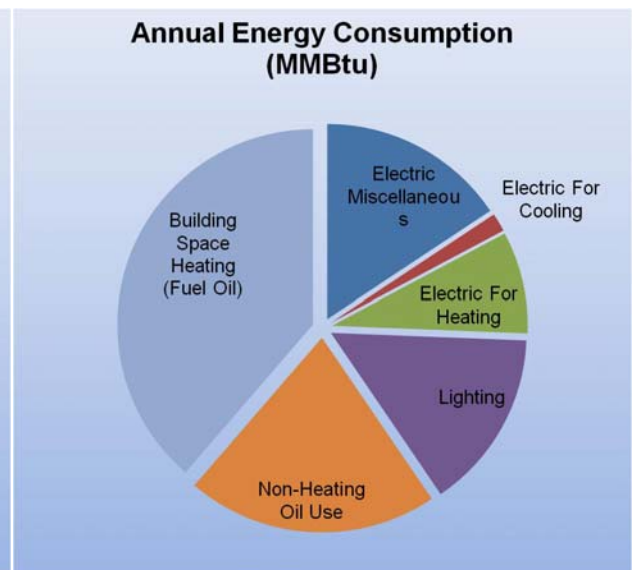
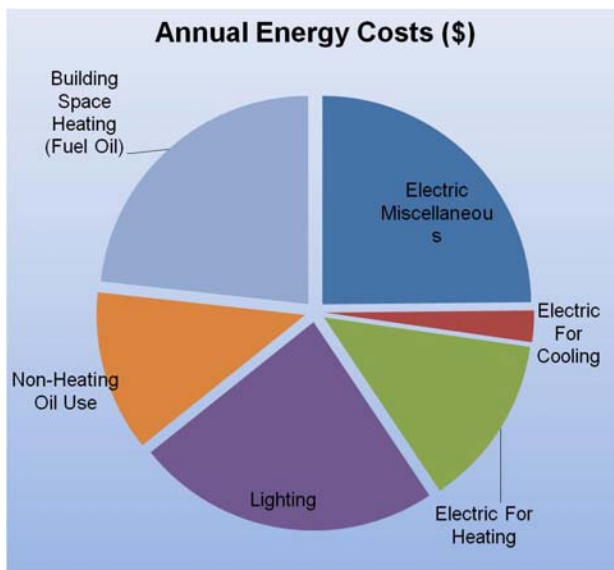
The chart below shows the projected monthly oil usage compared to the heating degree days or HDD. Heating degree days are the difference of the average daily temperature and a base temperature, on a particular day. The heating degree days are zero for the days when the average temperature exceeds the base temperature. SWA's analysis used a base temperature of 65 degrees Fahrenheit.



The table and associated pie charts on the following page demonstrate the estimated energy use breakdown for the Town Hall based on the 12 month utility bill analysis period. This information is based on engineering calculations and estimates of consumption for similar facilities. The electric load for heating includes the pumping costs associated with the hydronic heating system and fan energy used when the H&V Unit is operating. There is some electric heat in the Police Garage, although it is difficult to determine the frequency of operation of this space. These graphics are based on assumptions and engineering calculations and were not generated by the eQuest software.

Note: electrical cost at \$55/MMBtu of energy is over 2.5 times more expensive than oil at \$21/MMBtu.

Annual Energy Consumption / Costs					
	MMBtu	% MMBtu	\$	% \$	\$/MMBtu
Electric Miscellaneous	183	16%	\$9,997	25%	55
Electric For Cooling	18	2%	\$983	2%	55
Electric For Heating	99	8%	\$5,376	13%	55
Lighting	174	15%	\$9,511	24%	55
Non-Heating Oil Use	243	21%	\$5,028	12%	21
Building Space Heating	453	39%	\$9,363	23%	21
Totals	1,170	100%	\$40,257	100%	
Total Electric Usage	474	33%	\$25,866	56%	55
Total Fuel Oil Usage	975	67%	\$20,148	44%	21
Totals	1,449	100%	\$46,014	100%	



Energy benchmarking

SWA has entered energy information about the Essex Town Hall into the U.S. Environmental Protection Agency's (EPA) *ENERGY STAR® Portfolio Manager* energy benchmarking system. Although the space is primarily an office facility, it has been categorized as a non-eligible ("Other") space type in the benchmarking system. Buildings with greater than 10% floor area not used as office space cannot be classified as Offices for this analysis. The portions of the building used as Assembly Space (10%) and serving as the Resident Trooper's headquarters (5%) exceed 10% of the total building area. Due to the different nature of operations of these spaces, they are termed "Other." In addition, the lack of air conditioning and mechanical ventilation in the building makes comparison to typical office spaces inaccurate.

Buildings of comparable type are given a score (1-100) that reflects the performance relative to other buildings of similar use. Since this building is categorized under the "Other" space type, there is no rating available. Consequently, the Essex Town Hall is not eligible to receive a national energy performance rating at this time. In order to receive a rating score, more than 50% of the building must be defined by one of the following space types: Office, Bank/Financial Institution, Courthouse, Hotel, Hospital (Acute Care & Children's), K-12 School, Medical Office, Residence Hall/Dormitory, Retail Store, Supermarket, Warehouse (Refrigerated/Non-refrigerated), Wastewater Treatment Plant, or Data Center.

The Site Energy Use Intensity is 70 kBtu/ft²-yr compared to the national average of "Other" building types of 104 kBtu/ft²-yr. The Source Energy Use Intensity is 170.0 kBtu/ft²-yr compared to the national average of 213 kBtu/ft²-yr. Please note, the national average for "Other" space types is very subjective due to the nature of the calculation, which is based upon a survey of existing buildings of varying usage. Thus, it should not serve as an absolute when gauging performance.

SWA recommends that the information be updated in *Portfolio Manager* each year, so that annual changes in building consumption can be used as a better assessment of past and future building performance. This will also enable tracking of energy performance following the implementation of any building upgrades, so that the projected savings can be compared to actual savings over time.

To encourage and facilitate ongoing use of this free, web-based tool, SWA has created an *ENERGY STAR® Portfolio Manager* account on behalf of the Town of Essex and shared access to the Town Hall facilities information with this user account. This access will allow future data to be added and tracked using the benchmarking tool.

In order to log into the account that was set up on behalf of the Municipality and obtain access to SWA's shared Portfolio Manager file for this project, please visit the following website.

<https://www.energystar.gov/istar/pmpam/index.cfm?fuseaction=login.login>

Username: EssexTownHall
Password: EssexTownHall

See Appendix E for the Statement of Energy Performance report generated from the *ENERGY STAR® Portfolio Manager* tool.

Tariff analysis

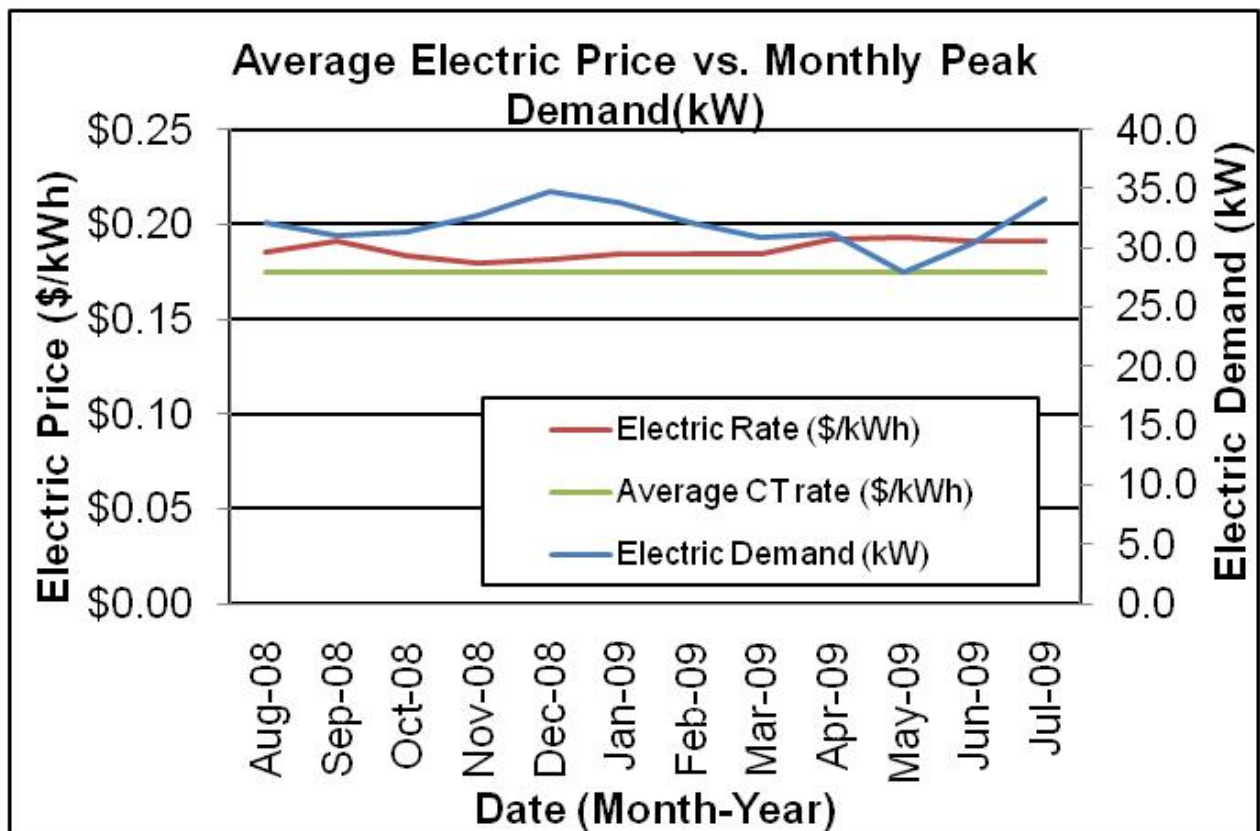
As part of the utility bill analysis, SWA evaluated the current utility rates and tariffs. Tariffs are typically assigned to buildings based on size and building type.

Per discussions at the kick-off meeting, it is SWA's understanding that the Town of Essex negotiates the best fuel oil rate possible each year through East River Energy. The current energy rates for the Town Hall are consistent with pricing for the region.

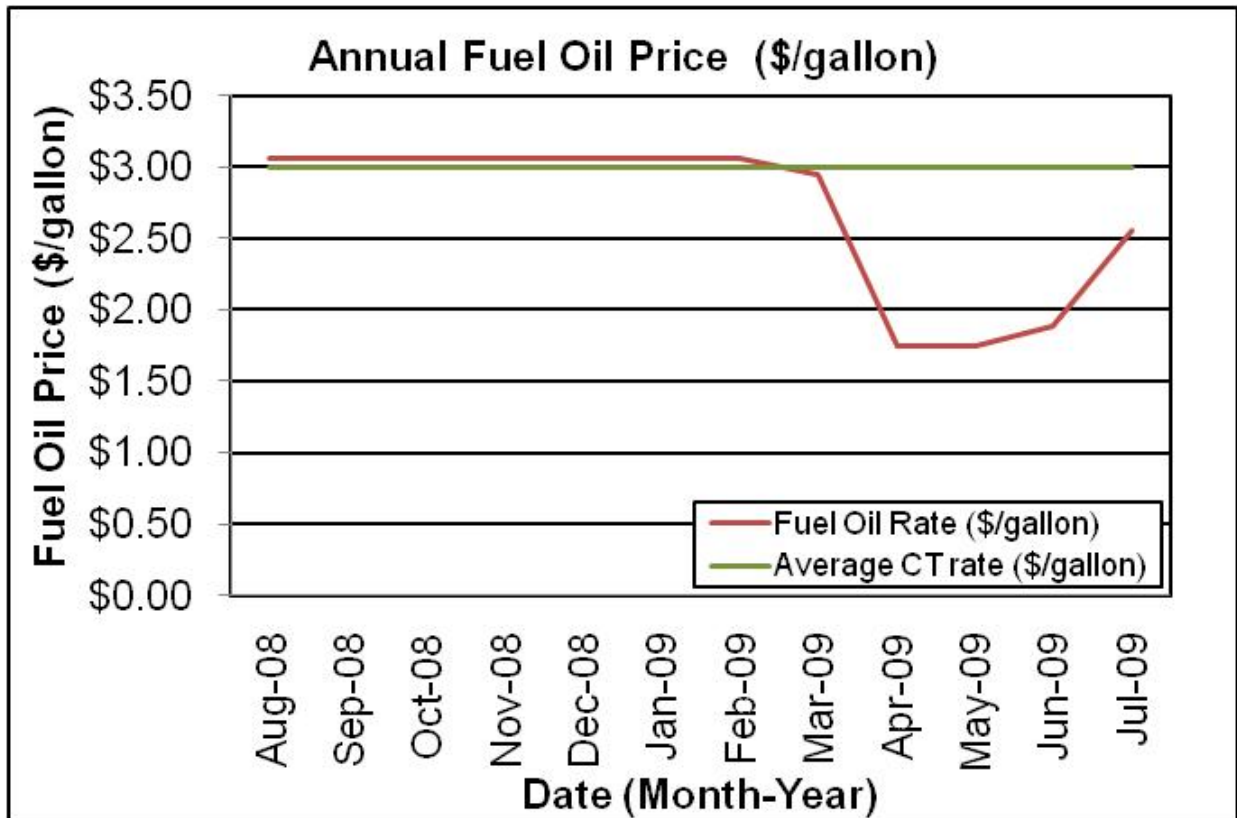
Energy Procurement strategies

Billing analysis is conducted using an average aggregated rate that is estimated based on the total cost divided by the total energy usage per utility per 12 month period. Average aggregated rates do not separate demand charges from usage, and instead provide a metric of inclusive cost per unit of energy. Average aggregated rates are used in order to equitably compare building utility rates to average utility rates throughout the state.

For this analysis, SWA compared the utility rate with an average estimated commercial electric utility rate of \$0.175/kWh. The Town Hall is billed at an average rate of \$0.186/kWh. Electric bill analysis shows very little fluctuations in pricing over the most recent 12 month period and a fairly constant electrical demand.



The Town Hall pays an average rate of \$2.89/gallon for fuel oil. The annual fuel oil profile below shows significant price fluctuations during the heating season in the most recent 12 month period. This is typical for oil pricing and indicates that the savings associated with heating recommendations, which are based on an average fuel oil rate of \$2.50/gallon, are conservative with respect to the actual winter rates that exceed \$3.00/gallon.



Appendix C contains links to websites that offer additional information on third-party energy suppliers in the Essex service area.

EXISTING FACILITY AND SYSTEMS DESCRIPTION

This section gives an overview of the current state of the facility and systems. Please refer to the Proposed Further Recommendations section for recommendations for improvement.

Building Characteristics

The Essex Town Hall is a three-story building with a portion of the ground level partially below grade. Originally built in 1892, a stair tower and core space were added to the historic building in 1976 to improve access and provide restroom facilities. At that time, some modifications were made to the façade and a number of windows were bricked over. More recently, new wood flooring and finishes were installed on the first floor. The building is approximately 24,000 ft² and houses town offices, a conference room, the Resident State Trooper's office, and a public assembly space.

Building Occupancy Profiles

The building is open to the public from 9 am to 4 pm Monday through Friday. There are approximately 35 people in the building during this time, including office staff and visitors to the various town departments housed in the facility. Hours of operation for the Resident State Trooper's Office vary. There is also a public assembly space that is used for meetings and gathering in the evenings. The schedule of use for the assembly space changes each week, with events typically running from 6 pm to 9 pm.

For the purposes of this analysis, it was assumed that the building typically operates for 60 hours per week, including the police and assembly areas. No weekend hours were assumed.

Building Envelope

General Note: All findings and recommendations on the exterior envelope (base, walls, roofs, doors and windows) are based on the energy auditors' experience and expertise, on construction document reviews (if available), and on detailed visual inspection, as far as accessibility and weather conditions allowed at the time of the field audit.

Due to the mild weather conditions on the day of the site visit, no exterior envelope infrared (IR) images were taken during the field audit. A minimum temperature difference of 18 F between the inside and outside is required for useful results.

Exterior Walls

The exterior walls of the original building, circa 1892, are comprised of three courses of brick with a plaster finish on the interior. The façade is primarily brick veneer with some granite accents. As is typical in this type of construction, the walls of the main building are uninsulated. No details of the existing building were available and no drawing references were found that would indicate insulation was added in 1976. (Approximately R-1)

The walls of the newer stair tower and core space are comprised of concrete masonry (CMU) block with a brick veneer and layer of rigid insulation in the cavity. These walls have similar energy performance to the older walls, approximately R-1. The police garage is assumed to be CMU with a stucco finish. The age of the garage is unknown but it is assumed to have a minimal amount of rigid insulation. The insulated portions of the building are small relative to the original building.

Exterior and interior wall surfaces were inspected during the field audit. There was evidence of moisture problems in some locations, including the front vestibules and the upper ceiling in the bathroom adjacent to the First Selectman's Office. In most cases, the moisture damage appeared to be associated with moisture intrusion from roof leaks. Discussions with the building maintenance staff indicate that the roof leaks have been addressed and the visible problems are not ongoing. Some staff also indicated significant amounts of moisture on the interior walls. This is likely the result of condensation during the summer months when window air conditioning units are operating and the cold air comes into contact with the warmer, uninsulated brick walls.

The following specific exterior wall problem spots and areas were identified:



Figure 1- Vestibule Water Damage near roof drain



Figure 2 - Water Damage in First Selectman's Bath

Roof

According to the building maintenance staff, the main roof was installed in the late 1980s or early 1990s. It is an asphalt, built-up roof assumed to have some rigid insulation in-place. The flat roof is at least 20 years old and has areas of ponding and soft spots. According to building maintenance staff, it requires patching on an annual basis. As evidenced on the walls, it has allowed moisture intrusion to the building.

However, the flat roof is not serving as the thermal envelope in this building. A drop ceiling has been added to the upper level of the building and has been framed to support lighting fixtures and fiberglass insulation. This creates an attic space between the upper floor and the roof. The existing insulation is approximately 6" deep or an equivalent of R-21. SWA has identified an opportunity for increasing the attic insulation levels.

Building maintenance staff reported a planned roof replacement for the area over the elevator core, following asbestos abatement in that area. SWA recommends the main roof be replaced to ensure durability for the building and prevent long-term moisture problems. Planning for this capital improvement should include proper abatement of any asbestos containing material in the existing roof.



Figure 3 - Existing Attic Insulation

Base

The main building has a full basement that is partially below grade on the South side. The grade drops and the majority of the basement is at grade level, including a slab on grade below the Police Garage. The portions of the basement below grade, on the South side, had signs of moisture build-up and the building maintenance staff typically runs window air conditioning units continuously to dehumidify the spaces. The foundation is not insulated.

Windows

The main portion of the historic building has single-pane wooden windows throughout the façade. In some locations, the window openings were bricked over during the 1976 renovation. Replacement windows have been installed in some more concealed areas of the building. The wooden windows typically have exterior storm windows installed. The windows require regular maintenance and are a significant source of air infiltration. Occupants report comfort issues related to the windows. To address these concerns, SWA performed energy and cost analysis for the window replacement.

eQuest software default values for single-pane, wooden windows were used for the energy model. Infiltration associated with the windows was estimated and then adjusted to align the modeled annual oil consumption with the average heating bills.



Figure 4 - Exterior Storm Window



Figure 5 - Typical single-pane, wood window

Exterior doors

The front façade of the building has wooden doors at each vestibule with secondary doors on the interior. The rear façade has metal glazed vestibule doors. There are additional metal doors serving the boiler room and auditorium, as well as overhead garage doors in the Police Garage. All exterior doors, thresholds, related flashing, caulking and weather-stripping were inspected for signs of moisture, air-leakage and other energy-compromising issues. SWA recommends that the weather-stripping be repaired and/or replaced, as needed, for all doors to minimize drafts and reduce air leakage.

Building air-tightness

Based upon visual inspection and occupant feedback, the building is not well-sealed. Ventilation from the building is provided through openings in the walls, which remain open year-round and create an uncontrolled source of air infiltration. As noted previously, the windows are also a significant source of air infiltration. During winter building operation, occupants reported daily temperature swings associated with building stack effect that are likely the result of air infiltration.

If the windows are replaced, a large portion of the air leakage will be addressed. Similarly, recommendations associated with the ceiling insulation include provisions for air sealing the upper level. However, the infiltration associated with the ventilation louvers cannot be mitigated without providing mechanical ventilation for the building. Cost and feasibility are two limiting factors for upgrading the ventilation system. At this time, SWA does not recommend changes to the existing natural ventilation used in this building.

For energy modeling purposes, infiltration associated with the windows was estimated and then adjusted to align the modeled annual oil consumption with the average heating bills.

Mechanical Systems

Heating, Ventilation, and Air Conditioning Overview

The building is heated by a single boiler serving three zones of hydronic baseboard, one per floor. Each floor has a zone pump, which operates continuously when the outdoor temperature is below 60 degree F. Individual spaces within each zone have thermostats that operate zone valves, which control the water flow through corresponding sections of baseboard. In many cases, multiple rooms are served by a single zone valve and thermostat, often resulting in overheating in some areas. One example of overheating is the second floor Media Room (Room B), which shares a thermostat with the Assessor's Office and the Tax Collector's Office.

The building does not contain a mechanical cooling system. Local space cooling is provided via window air conditioning units. Approximately 20 window units are stored on-site for use during peak summer months. In some cases, the window units remain in-place year round. On the south-west corner of the ground level, a window air conditioning unit is run continuously to address moisture concerns. The server room on the first floor is also continuously cooled by a through-the-wall air conditioning unit.

The building was designed to provide natural ventilation using a combination of operable windows and air inlets behind the perimeter baseboard heating elements. During the winter, the heating elements create a convective air current that draws fresh air into the building through the outdoor openings. In the summer months, occupants would not traditionally have had access to mechanical cooling. The operable windows would have provided some measure of comfort through increased air movement.

With the availability of window air conditioning units, many of the office spaces are now operated during the summer months with the windows closed. The passive air inlets still provide some fresh air to the spaces, however, they are an uncontrolled source of fresh air. Depending upon weather conditions, the ventilation rate may be higher or lower than required to maintain good indoor air quality. If the ventilation rate is excessive, it represents an energy penalty because excess outdoor air must be mechanically conditioned.

However, the outdoor inlets cannot be closed to save energy without negatively impacting the code-required ventilation levels needed by the occupants. During periods of high humidity, the air inlets continuously introduce moisture to the spaces and it may exceed the latent capacity of the window air conditioning units, resulting in continuous operation of the equipment and possibly condensation on the interior side of the exterior wall surfaces.

The maintenance office on the ground level is partially below grade and does not have windows. To address ventilation and moisture in this space, the occupants manually operate an exhaust fan, as needed. There are also timer controlled bathroom exhaust fans.

The large assembly space has a small section of baseboard heat during regular operation. When there are events, the maintenance staff manually operate a Heating and Ventilating Unit that is served by a hot water coil controlled by a fourth zone pump fed by the boiler. At the time of the site visit, the damper controlling fresh air to the H&V Unit was closed. Maintenance staff reported that occupants typically open the exterior door if the space becomes stuffy. Operating the H&V Unit with the damper closed provides maximum energy efficiency but does not address the ventilation requirements of the space. Ventilation requirements for this space should be reviewed and the damper adjusted accordingly.

A comprehensive Equipment List can be found in Appendix A.

Heating and Ventilation Equipment

The building is heated by a single boiler serving three zones of hydronic baseboard, one per floor. Each floor has a zone pump, which operates continuously when the outdoor temperature is below 60 degree F. Originally a coal-fired boiler, it was converted to operate on oil. The manual two-stage oil burner has a rated input of 980,000 Btu/hr on high fire and a measured combustion efficiency of 80.6% on low fire. The estimated boiler output capacity is 790,000 Btu/hr. Energy modeling for the building found the boiler capacity exceeds the building load requirements by a factor of 3 or more.

Although the exact age of the boiler is unknown, it has far exceeded the 20 year life expectancy of a typical boiler. SWA assessed the payback associated with a full boiler replacement but found that it was not cost-effective based on energy savings alone. However, the boiler replacement and associated controls would provide energy cost savings and could provide improved occupant comfort by modulating the boiler output to align with the building heating demand. On mild days, this may minimize overheating in spaces containing a large amount of baseboard, particularly those that share a zone thermostat.

Given the age of the equipment, SWA recommends that planning for this upgrade be strongly considered. Planning for the replacement before a boiler failure occurs will allow for consideration of energy issues, which are often disregarded when emergency boiler replacement is required. As a result, boilers are often replaced quickly but with standard efficiency equipment, resulting in a missed opportunity for savings. In the interim, SWA has made recommendations for controls that will result in energy savings and have a reasonable payback period.

The boiler has four associated zone pumps, one per floor and an additional pump dedicated the heating coil in the air handling unit that serves the assembly space. The Heating and Ventilating (H&V) Unit pump is manually disabled unless a meeting in the assembly space is scheduled. The other three zone circulating pumps operate continuously and have controls to disable them when the outdoor temperature rises above 60 F. The boiler supply temperature is set at 185 F and there are no outdoor reset controls installed.

No mechanical drawings were provided to SWA as part of this study. Per the Architectural drawings provided to SWA, the Mechanical and Electrical Design were done by Helenski Associates Inc. in 1976. For the Heating and Ventilating Unit (H&V Unit), the original design documents may identify the design requirements for ventilation. If so, the damper could be adjusted to provide the needed ventilation air for the assembly space. If the Town intends to provide cooling and/or mechanical ventilation in the main building, a design engineer should be hired to provide a ventilation feasibility study.



Figure 6 - Oil-fired boiler and zone pumps

The large assembly space is heated by the H&V Unit that is served by a hot water coil controlled by a fourth zone pump fed by the boiler. It is a Trane Climate Changer unit and was installed in approximately 1995. Equipment of this type often lasts for 20 years. Although this unit is 15 years old, it is not used continuously and may have a much longer service life.

When there are events, the maintenance staff manually operate the H&V Unit. At the time of the site visit, the damper controlling fresh air to the H&V Unit was closed. Many times, the staff do not enable the heating coil because occupant-generated heat is sufficient. If the damper were open, the heating coil would need to operate more continuously to maintain the space temperature while providing fresh air. Although operating the H&V Unit with the damper closed provides maximum energy efficiency, it does not address the ventilation requirements of the space. SWA recommends that the ventilation requirements for this space be reviewed and the outdoor damper adjusted accordingly.

There is one small exhaust fan serving the maintenance office on the ground level and a roof-mounted exhaust fan serving the restrooms. The age of the fans is unknown. In addition, there is a small air handling unit providing fresh air to the Police Garage. Details on this unit could not be obtained because the equipment was not accessible. A portion of the Police Garage is used as a workout space and is heated, as needed, by electric unit heaters. These units are manually controlled at the electric panel and have unit-mounted thermostat dials set to minimize operation when the space is not in use.

Distribution Systems

On each floor, space temperature is controlled by thermostats and associated Honeywell zone valves. According to the building maintenance staff, the zone valves were all recently replaced. Some comfort issues exist in areas where multiple spaces are controlled by a single zone valve. SWA is recommending programmable thermostats to control the space temperatures. The existing rotary thermostats allow a large variation in temperature and must be manually set back at night.

The zone valves supply a perimeter heat distribution system. The offices are typically served by baseboard radiation. The corridors and vestibules are served by unit ventilators.

The H&V Unit has a ducted return, outdoor air inlet, and a main supply trunk. A hydronic heating coil from the boiler serves the unit.

As noted previously, cooling is provided through window air conditioning units in the offices and the building uses natural ventilation methods. Many of the offices have ceiling fans installed to provide air circulation. Summer humidity and heat are a concern for the occupants and options for central cooling were requested.

In terms of energy usage, an increase in central cooling within the building will have a corresponding increase in energy consumption and operating costs. There are split-system air conditioning systems available that may offer greater efficiency and longevity relative to the window units for select spaces such as the server room. However, facilities staff indicated that location of compressors is an aesthetic concern and is undesirable on the exterior of the building. If central cooling were installed, the passive outdoor air inlets would negatively impact the energy consumption of the system. Since room for ductwork is limited, it is unlikely that code requirements for mechanical ventilation can be provided for the building. SWA does not recommend that central cooling be installed in the building.

Controls

Space temperature is controlled by non-programmable thermostats. SWA is recommending outdoor reset controls for the boiler and programmable thermostats in the zones.

The majority of the building equipment is manually adjusted and controlled by the building maintenance staff. Original controls for the H&V unit have been disabled and the staff feels it is cost-prohibitive to replace the systems. The current energy efficiency of the building is the result of diligence on the part of the facility operators. In the evenings and mornings, operators manually adjust thermostats, turn off lights, and control equipment. These practices are currently effective but rely on careful attention. Automated building controls provide a greater level of control, however, they require a financial investment. With the exception of programmable thermostats and boiler controls, automated controls are not cost-effective. Current operating practices for other equipment are managing the energy well.

Domestic Hot Water

The domestic hot water (DHW) for the Town Hall is provided by a 50 gallon Bradford White oil-fired storage tank. The unit has an average efficiency rating and was installed in 2008. There is an opportunity to decrease domestic hot water consumption through the installation of more efficient water fixtures. Efficient water-consuming fixtures and appliances save energy and money through reduced energy consumption for water heating, as well decreased water and sewer bills. Water efficient fixtures include low-flush toilets (1.6 gallons per flush), efficient sink aerators, and automatic timers programmed to operate the sinks for 20 seconds. Routine maintenance practices that identify and quickly address water leaks are another low-cost way to save water and energy.

Electrical systems

Lighting

See attached lighting schedule in Appendix B for a complete inventory of lighting throughout the building, including estimated power consumption and proposed lighting recommendations.

Interior Lighting - The Town currently contains mostly T8 fixtures with electronic ballasts. There are occupancy sensors in the bathrooms and timer controls on the exterior lighting.

Exit Lights - Exit signs were found to be LED type.

Exterior Lighting - The exterior lighting surveyed during the building audit was found to be a mix of Metal Halide lamp and High Pressure Sodium. Exterior lighting is controlled by timers.

Appliances and process

Appliances and other miscellaneous equipment account for a significant portion of electrical usage within the building. Typically, appliances are referred to as “plug-load” equipment, since they are not inherent to the building’s systems but rather plug into an electrical outlet. Equipment such as computers, computer servers, radio and dispatch equipment, refrigerators, vending machines, printers, etc. all create an electrical load on the building that is difficult to control.

Equipment and appliances, such as refrigerators that are over 10 years of age, should be replaced with newer efficient models with the Energy Star label. For example, Energy Star refrigerators use as little as 315kwh/hr. When compared to the average electrical consumption of older equipment, Energy Star equipment results in a large savings. Look for the Energy Star label when replacing appliances and equipment, including: window air conditioners, refrigerators, printers, computers, copy machines, etc. More information can be found in the “Products” section of the Energy Star website at: <http://www.energystar.gov>

During the walk-through, SWA observed a number of refrigerators and microwaves and coffee makers. Each of these pieces of equipment represents a plug-load. If possible, these devices should be consolidated to minimize the energy consumption. Facility maintenance staff indicated that a portion of the window air conditioning units are upgraded annually with Energy Star models. SWA recommends replacing the most frequently run and continuously operating units first, to maximize the energy savings.

Refrigerated vending machines operate 24 hours per day, seven days a week. In addition to consuming 2,500 to 4,400 kilowatt-hours (kWh) of energy per year, they contribute to increased cooling loads within the building. For a low average electricity cost of \$0.08/kWh, annual operating costs can range from \$200 to \$350.

New, more efficient vending machines are available that can greatly reduce operating costs. A typical vending machine with a lighted front display panel uses two or three 4- or 5-foot high-output T12 fluorescent lamps powered by conventional magnetic ballasts. The lights alone draw up to 180 watts of power. This continuous load consumes 1,580 kWh per year, which equate to an annual total cost of \$126 at a low average rate of 8¢ per kWh. The heat from the lights also increases the machine's refrigeration load.

Building owners should request machines that use low-temperature electronic ballasts with T8 lamps, which could reduce lamp power by approximately 80 watts. In addition, high-color-rendering T8 lamps can significantly improve the appearance of the translucent front panel. In one test, disconnecting the lights on a vending machine cut energy use by 35%.

Additionally, the use of timers or occupancy sensors can lead to significant savings by activating the machines only when a customer is present or when the compressor must run to maintain the product at the desired temperature. At least one device now on the market uses a passive infrared occupancy sensor (PIR) to turn off the compressor and fluorescent lights in the vending machine when no one is around. In addition, a temperature sensor powers up the machine at appropriate intervals to keep the products cool.

During typical operation, power to the vending machine is shut-off after the area has been vacant for 15 minutes. For a machine located in a room maintained at 70 degrees Fahrenheit, the device is designed to shut down the equipment for up to two hours if there is no occupant traffic in the area. After two hours, the machine is turned back on to run a compressor cycle. Upon completion of the cycle, the unit will shut-off again if the occupancy sensor still has not been triggered.

When someone approaches, the sensor sends a signal to activate the lights and other electronic components. If needed, the compressor will also run a cooling cycle while the machine is activated. After the machine is repowered, the control logic ensures that the compressor is allowed to run a complete cooling cycle before it is powered down again. A sensor also determines whether the compressor is running and prevents the machine from shutting down until the cycle has been completed.

Both of these features ensure that a high-head-pressure start, which would strain the compressor, never occurs. An indicator light goes on if the compressor has been running for more than two hours—a signal that maintenance may be required.

Savings for vending machines equipped with these devices range from 24 to 76%, depending on usage patterns, occupancy in the area, and ambient conditions. Occupancy sensors can be most cost-effective when the machine is located in such a way that people trigger the sensor only when they want to purchase something.

Elevators

SWA evaluated the potential for upgrading the existing direct current (DC) elevator technology to utilize Silicon Controlled Rectifiers, which utilize a variable speed drive. Although the electrical savings are significant, the high retrofit cost and age of the existing equipment make this recommendation cost prohibitive. This technology should be considered at the time of elevator replacement.

Other electrical systems

The building has a 150 kW Cummins oil-fired Generator on-site. According to facilities staff, the building participates in an electrical Demand Response Program. The Generator runs weekly to ensure it is operational. In addition, it runs during power outages and when required during periods of peak electrical demand.

RENEWABLE AND DISTRIBUTED ENERGY MEASURES

Renewable energy is defined as power generated from sources which are naturally replenished, such as sunlight, wind, and geothermal. Due to both demand and the availability of state and federal government-sponsored funding, technology for renewable energy is improving and the cost of installation is decreasing. Renewable energy reduces the need for using electricity or fossil fuel, therefore lowering costs by minimizing the amount of energy purchased from the utility company.

Technologies such as photovoltaic panels or wind turbines, use natural resources to generate electricity on the site. Geothermal systems offset the thermal loads in a building by using the earth as either a heat sink or heat source. Solar thermal collectors heat a specified volume of water with energy from the sun, reducing the amount of energy required to generate hot water using the building's mechanical equipment. Cogeneration or Combined Heat and Power (CHP) allows local generation of electricity, while also taking advantage of heat wasted during the generation process.

Existing systems

Currently there are no renewable energy systems installed in the building.

Evaluated Systems

Solar Thermal Collectors

Solar thermal collectors are not cost-effective for this building and would not be recommended due to the insufficient and intermittent use of domestic hot water throughout the building to justify the expenditure.

Solar Photovoltaic

Photovoltaic panels convert light energy received from the sun into a usable form of electricity. Panels can be connected into arrays and mounted directly onto building roofs, as well as installed onto built canopies over areas such as parking lots, building roofs or other open areas. Electricity generated from photovoltaic panels is generally sold back to the utility company through a net meter. Net-metering allows the utility to record the amount of electricity generated in order to pay credits to the consumer that can offset usage and demand costs on the electric bill. In addition to generation credits, there may be incentives available called Solar Renewable Energy Credits (SRECs) that are subsidized by the state government.

Based on utility analysis and a study of roof conditions, the Town Hall has sufficient space for a 20 kW Solar Panel installation. However, current incentives do not provide a reasonable payback for this measure. See ECM #6 for details.

Geothermal

The Town Hall is a potential candidate for geothermal installation since it is currently served by a hydronic baseboard heating system fed by an aging boiler. However, this would incur significant costs to core wells, which may not be feasible in the downtown location and the well field may impact the current parking. Soil analysis and a feasibility study would be required to assess the potential energy savings associated with geothermal.

Combined Heat and Power

The Town Hall is not a good candidate for CHP installation and would not be cost-effective due to the size and operations of the building. Typically, CHP is best suited for buildings with a high electrical baseload to use the electricity generated and a means for using waste heat generated.

Wind

This site is not a good candidate for wind power generation due to insufficient wind conditions. The payback period for wind turbine systems is long and ground-based wind turbines require multitudes of approval from various authorities, which can be very time consuming at a small scale. The Town Hall also has aesthetic constraints that make this technology less attractive.

FINDINGS AND RECOMMENDATIONS

Based on the assessment of this building, SWA has separated the investment opportunities into four categories of recommendations:

1. Capital Improvements – Upgrades not directly associated with energy savings
2. Operations and Maintenance – Low Cost/No Cost Measures
3. Water Conservation Measures – Methods to reduce water and associated energy usage
4. Energy Conservation Measures – Higher cost upgrades with associated energy savings

Category I Recommendations: Capital Improvements

- Roof Replacement – SWA recommends that the roof be replaced to ensure durability for the building and prevent long-term moisture problems. Ponding and soft spots were identified on the existing roof. The roof should be replaced prior to the installation of any roof-mounted PV panels. Planning for this capital improvement should include proper abatement of any asbestos containing material. The existing roof is over an unventilated ceiling plenum. To decrease the amount of heat radiated into the upper story offices, a light-colored reflective roof is recommended. Cost will vary by roof type installed.
- Boiler Replacement – Based on the age and efficiency of the current boiler, SWA recommends planning for a boiler replacement. Although this will provide energy savings, this is not a cost-effective measure and may cost \$20-\$30,000. Planning for this capital improvement should include proper abatement of any asbestos containing material. The existing boiler is approximately three times larger than required to meet the current building loads. Smaller, more efficient equipment can replace the current boiler. SWA recommends two, modulating oil-fired boilers to share the load and provide redundancy. Any new boilers should include outdoor temperature reset controls.

Category II Recommendations: Operations and Maintenance

- Weather Stripping/Air Sealing – Doors and vestibules should be inspected annually for deficient weather-stripping and replaced as needed. The perimeter of all window frames should also be regularly inspected and any missing or deteriorated caulking should be repaired to provide an unbroken seal around the frame. Any other accessible gaps or penetrations in the thermal envelope should also be sealed with caulk or spray foam.
- Pipe Insulation – The energy efficiency of the heating plant and distribution system can be improved by repairing and/or replacing damaged pipe insulation. If asbestos is not present, this measure can be undertaken by maintenance personnel for minimal cost.
- Energy Star Equipment - When replacing equipment and appliances, look for efficient models with the Energy Star label. This includes: window air conditioners, refrigerators, printers, computers, copy machines, etc. More information can be found in the “Products” section of the Energy Star website at: <http://www.energystar.gov>. If possible, consolidate devices such as coffee makers, microwaves, and refrigerators to minimize energy consumption. When window air conditioning units are upgraded annually, SWA recommends prioritizing replacement of the most frequently run and continuously operating units with Energy Star models, to maximize the energy savings.
- Ventilation - The fresh air requirements for the public assembly space should be reviewed and the outdoor air damper on the H&V Unit should be adjusted accordingly.
- Programmable Thermostats – Programmable thermostats are a simple and cost-effective way to reduce operating costs and improve control during unoccupied periods. Programmable thermostats should be installed and the program settings should be reviewed to ensure appropriate schedules and setpoints are being maintained.

Category III Recommendations: Water Conservation Measures (WCMS)

- **Water Efficient Fixtures & Controls** - There are many retrofit options, which can be installed now or incorporated as equipment is replaced, to save water and reduce domestic hot water demand and the energy required to heat the water. Building staff can easily install faucet aerators and/or low-flow fixtures to reduce water consumption. Routine maintenance practices that identify and quickly address water leaks are a no cost/low-cost way to save water and energy. Retrofitting with more efficient water-consuming fixtures and appliances also saves energy and money through reduced energy consumption for water heating, while decreasing water and sewer bills. Adding controlled on/off timers on lavatory faucets requires a larger investment but is another option for providing water savings.

Category IV Recommendations: Energy Conservation Measures (ECMs)

Energy Conservation Measures (ECMs) are recommendations determined for the building based on improvements over current building conditions. ECMs have been determined for the building based on installed cost, as well as energy and cost-savings opportunities.

ECM#	Description of Energy Conservation Measures
1	Lighting Upgrades: See Appendix B
2	Boiler Outdoor Temperature Reset Controls
3	Ceiling Insulation and Air Sealing
4	Install Vending Miser
5	Window Replacement
6	Install 20 kW PV rooftop system

Please note: For the measures proposed, the project may be eligible for incentives through CL&P. However, the incentives may not be applicable or may be prorated based on the heating fuel. To be conservative, no incentives were assumed in this analysis. As a result, the Annual Return on Investment values shown in the tables throughout this report are fractional numbers and appear as zeros. SWA suggests this report be submitted to a CL&P representative to verify any potential incentives for which the project may qualify.

ECM#1: Building Lighting Upgrades

During the site visit, SWA completed a lighting inventory of the Town Hall (see Appendix B). The existing lighting consists of mostly T8 fluorescent fixtures with electronic ballasts. SWA recommends installing occupancy sensors in offices and areas that are occupied only part of the day and where payback on savings is justified. Typically, occupancy sensors have an adjustable time delay that shuts down the lights automatically if no motion is detected within a set time period. Advanced micro-phonic lighting sensors include sound detection as a means to control lighting operation. SWA also evaluated the installation of daylighting controls in the main stairwells.

SWA recommends replacing incandescent and halogen lamps with CFL lamps. Also, SWA recommends replacing the Metal Halide lamps with Pulse Start Metal Halide lamps. Pulse Start Metal Halide (MH) lamps offer the advantages of standard (probe start) MH lamps but minimize the disadvantages. They produce higher light output both initially and over time, operate more efficiently, produce whiter light, and turn on and re-strike faster. Due to these characteristics, energy savings can be realized via one-to-one substitution of lower-wattage systems or by taking advantage of higher light output and reducing the number of fixtures required in the space. The labor in all these installations was evaluated using prevailing electrical contractor wages.

Installation cost:

Estimated installed cost: \$9,397

Source of cost estimate: RS Means

ECM #	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime energy cost savings, \$	simple payback, yrs	annual return on investment, %	CO ₂ reduced, lbs/yr
1	9,397	0	9,397	12,653	0	N/A	1.8	0	2,353	15	35,302	4.0	0	22,655

Assumptions: SWA calculated the savings for this measure using information collected during the field visits and using the billing analysis.

Rebates/financial incentives:

The following utility incentives through CL&P are available for lighting retrofit measures.

- Up to \$25 for incandescent fixtures retro-fitted with hard-wired compact fluorescent fixtures (\$225 maximum incentive)
- Up to \$30 for the replacement of metal halide fixtures with pulse start metal halide fixtures (minimum 50 Watt lamp reduction, \$150 maximum incentive)
- Currently there are no incentives for the installation of motion sensors

Please see Appendix F for the following website for more information on Incentive Programs.

<http://www.cl-p.com/Business/SaveEnergy/BusinessRebates.aspx>

ECM#2: Boiler OutdoorTemperature Reset Controls

The existing boiler supplies 185 degree F supply water temperature when it operates. SWA is recommending the addition of boiler controls that will vary the supply water temperature based on the outdoor air temperature. This enables the heating system to adjust the rate of heat delivery to match the heat loss of the building. With outdoor reset, the boiler supply temperature is lowered as the outdoor temperature rises. This matches the boiler operation to the building needs and reduces fuel consumption. In addition to saving energy, this control can decrease overheating in the spaces and improve occupant comfort. Savings typically range from 5% to 30% of the heating costs. For this analysis, a savings of 8% was assumed.

Installation cost:

Estimated installed cost: \$5,000

Source of cost estimate: RS Means

ECM #	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime energy cost savings, \$	simple payback, yrs	annual return on investment, %	CO ₂ reduced, lbs/yr
2	5,000	0	5,000	0	0	362	2.1	0	906	10	9,058	5.5	0	8,110

Assumptions: SWA calculated the savings for this measure using information collected during the field visits and using the billing analysis.

Rebates/financial incentives:

Please see Appendix F for more information on Incentive Programs.

ECM#3: Ceiling Insulation and Air Sealing

A drop ceiling has been added to the upper level of the building and has been framed to support lighting fixtures and fiberglass insulation. This creates an unventilated attic space between the upper floor and the roof. The existing insulation is approximately 6" deep or an equivalent of R-21. SWA has identified an opportunity for increasing the attic insulation levels.

The heat produced by the drop-in light fixtures is emitted into the above-ceiling plenum and combined with solar gains radiating down from the dark colored flat roof. The above-ceiling plenum is unventilated, which traps the heat and radiates it back into the building. A minimum amount of insulation is installed, which is not sufficient to buffer the space. In the summer, this results in higher space temperatures on the upper floors. During the winter months, occupants have reported significant air movement between floors. This is likely the result of poor air sealing in the building, including the area around, and penetrations through, the upper plenum.

SWA recommends three steps to improving the upper thermal boundary of the building. First, the above-ceiling plenum should be ventilated to reduce radiation effects back into the space during the hot summer months. Second, the connection between the above-ceiling plenum and the conditioned space should be air-sealed to prevent air movement and reduce infiltration. This includes sealing the top plates and penetrations for HVAC, plumbing, and electrical penetrations. Finally, additional blown-in insulation should be installed. SWA recommends a minimum of R-10 blown-in fiberglass insulation, in addition to the R-21 existing insulation, for this application. Feasibility of increased insulation depth should be reviewed with respect to available above-ceiling space and price quotes. Air sealing is a key component of this recommendation.

In addition to providing energy and cost savings, SWA anticipates this recommendation will provide increased comfort year round. The air sealing and insulation will reduce drafts during the winter months. In the summer months, this measure should decrease overheating on the upper level.

Installation cost:

Estimated installed cost: \$5,000

Source of cost estimate: RS Means

ECM #	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime energy cost savings, \$	simple payback, yrs	annual return on investment, %	CO ₂ reduced, lbs/yr
3	5,000	0	5,000	0	0	169	1.0	0	423	15	6,345	11.8	0	3,787

Assumptions: SWA calculated the savings for this measure using information collected during the field visits and using the billing analysis. SWA analyzed this measure using eQuest software to model the building. The model assumed R-30 attic insulation and a slight decrease in air infiltration in the upper level.

Rebates/financial incentives:

Please see Appendix F for more information on Incentive Programs.

ECM#4: Install Vending Miser Controls

Description:

The Ground Level has one vending machine. Energy vending miser devices are now available for conserving energy with these vending machines. There isn't a need to purchase new machines to reduce operating costs and greenhouse gas emissions. When equipped with the vending miser devices, refrigerated beverage vending machines use less energy and are comparable in daily energy performance to new ENERGY STAR qualified machines. Vending miser devices incorporate innovative energy-saving technology into small plug-and-play devices that installs in minutes, either on the wall or on the vending machine. Vending miser devices use a Passive Infrared Sensor (PIR) to: Power down the machine when the surrounding area is vacant; Monitor the room's temperature; Automatically repower the cooling system at one- to three-hour intervals, independent of sales; Ensure the product stays cold.

With the snacks vending miser device, maximum energy savings can be achieved, that result in reduced operating costs and decreased greenhouse gas emissions with existing machines. Snacks vending miser devices also use a Passive Infrared Sensor (PIR) to determine if there is anyone within 25 feet of the machine. It waits for 15 minutes of vacancy, then powers down the machine. If a customer approaches the machine while powered down, the snacks vending miser will sense the presence and immediately power up.

Installation cost:

Estimated installed cost: \$430

Source of cost estimate: www.usatech.com and established costs

Economics (without incentives):

ECM #	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime energy cost savings, \$	simple payback, yrs	annual return on investment, %	CO ₂ reduced, lbs/yr
4	430	0	0	2,536	0	N/A	0.4	0	472	12	5,660	0.9	1	3,474

Assumptions: SWA assumes energy savings based modeling calculator found at www.usatech.com.

Rebates/financial incentives:

This measure may qualify for a utility rebate.

ECM#5: Window Replacement

The main portion of the historic building has single-pane, wooden windows throughout the façade. The wooden windows typically have exterior storm windows installed. The windows require regular maintenance and are a significant source of air infiltration. Occupants report comfort issues related to the windows. To address these concerns, SWA performed an energy and cost analysis for the window replacement.

Since the building is not mechanically cooled, the savings associated with the window replacement are for heating only. In addition to cost savings, new windows will likely improve occupant comfort and increase the durability and aesthetics of the building. New windows may also require less maintenance and provide increased security for the building. As shown below, window replacement is not a cost-effective measure based on energy savings alone and SWA does not recommend this measure. Please be aware that a building upgrade of this dollar amount may necessitate code compliance in other areas of the building, such as ventilation.

Installation cost:

Estimated installed cost: \$103,219

Source of cost estimate: RS Means

ECM #	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime energy cost savings, \$	simple payback, yrs	annual return on investment, %	CO ₂ reduced, lbs/yr
5	103,219	0	103,219	0	0	1,135	6.6	0	2,838	20	56,750	36.4	0	25,406

Assumptions: SWA calculated the savings for this measure using information collected during the field visits and using the billing analysis. SWA analyzed this measure using eQuest software to model the building. The base case model assumed single pane, wood windows and a high infiltration rate of 1.2 Air Changes per Hour (ACH). Post retro-fit, the model assumed double pane, low e wood windows and an infiltration rate of 0.6 ACH. SWA did not test the actual infiltration rate of the building. These assumptions are based on a correlation between the modeled performance and the utility bills. The post-retrofit infiltration rate of 0.6 ACH reflects continued air leakage through the ventilation air inlets.

Rebates/financial incentives:

Please see Appendix F for more information on Incentive Programs.

ECM #6: Install a 20kW Photovoltaic System

SWA assessed the feasibility of installing a Photovoltaic (PV) System on the roof of the Town Hall to generate electricity on-site. The roof is flat and fairly unobstructed, which is optimal for solar collection. Renewable energy systems, such as photovoltaic panels, can be mounted on the roof and offset a portion of the purchased electricity for the building. Utility companies generally have two separate electrical charges: usage and demand. Usage is the amount of electricity in kilowatt-hours (kWh) that a building uses each month. Demand is the amount of electrical power in kilowatts (kW) that a building uses at any given instance in the one month period.

During summer periods, when electric demand at a power station is high due to the amount of air conditioners, lights, equipment, etc. being used within the region, demand charges go up to offset the utility's cost of providing enough electricity at that given time. Photovoltaic systems not only offset the amount of electricity usage for a building but also reduce the building's electric demand from the utility, resulting in a higher cost savings as well. As shown in the cost analysis for a 20 kW PV system below, installation of this system is not cost-effective. Please note, roof replacement should be undertaken prior to installation of a roof-mounted PV system.

Installation cost:

Estimated installed cost: \$140,000 (Assumes \$7/Watt, including parts & installation)

Source of cost estimate: PV Watts Solar Calculator (www.pvwatts.org)

ECM #	est. installed cost, \$	est. incentives, \$	net est. ECM cost with incentives, \$	kWh, 1st yr savings	kW, demand reduction/mo	therms, 1st yr savings	kBtu/sq ft, 1st yr savings	est. operating cost, 1st yr savings, \$	total 1st yr savings, \$	life of measure, yrs	est. lifetime energy cost savings, \$	simple payback, yrs	annual return on investment, %	CO ₂ reduced, lbs/yr
6	140,000	0	140,000	23,900	20	N/A	3.4	0	4,445	25	111,135	31.5	-0.8	42,793

Assumptions: SWA calculated the savings for this measure based on an assessment of the roof shading done in the field visit and using the PV Watts Solar Calculator. Based on the billing analysis, a 20 kW PV system would offset a significant portion of the average monthly electrical demand, which is currently 32 kW. Assuming a collector area requirement of 10 Watts/ft² of electrical generation, the system would require approximately 2,000 ft² of roof area. The analysis was based on weather station data for Bridgeport, CT and assumes a fixed tilt collector array with a tilt of 41.2 degrees (latitude) and 180 degrees azimuth (south orientation). A derating factor of 0.77 was assumed for the conversion from DC to AC power.

Rebates/financial incentives:

- As noted in Appendix F, non-residential applications are not currently being accepted for PV installations in Connecticut. Therefore, no incentives were assumed in this analysis. This measure may also be eligible for State and Federal Tax Incentives, however, these are not reflected in the analysis.

Please see Appendix F for more information on Incentive Programs.

APPENDIX A: EQUIPMENT LIST

Inventory

Building System	Description	Model #	Fuel	Location	Space Served	Date Installed	Estimated Remaining Useful Life %
Heating	Air Handling Unit	Trane Climate Changer M-10	Hydronic	Mechanical Room	Public Assembly	1995	25-50%
Heating	Boiler, 80% est. htg. eff. 980,000 Btu/hr burner input	American Standard	Oil	Boiler Rm, Ground level	Entire Building	Unknown	0%
Domestic Hot Water	50 gal storage, oil-fired burner, 82% estimated effic.	Bradford White RF-50-6	Oil	Boiler Rm, Ground level	Entire Building	2008	80%
Lighting	See details - Appendix B	-	Electric	See details - Appendix B	Entire Building	Varies	Varies

Note: The remaining useful life of a system (in %) is an estimate based on the system date of built and existing conditions derived from visual inspection.

Appendix B: Lighting Study

Proposed Lighting Summary Table			
Total Gross Floor Area (SF)	24,000		
Average Power Cost (\$/kWh)	0.1860		
Exterior Lighting	Existing	Proposed	Savings
Exterior Annual Consumption (kWh)	5,668	3,416	2,251
Exterior Power (watts)	1,294	780	514
Total Interior Lighting	Existing	Proposed	Savings
Annual Consumption (kWh)	45,427	35,025	10,402
Lighting Power (watts)	19,810	19,230	580
Lighting Power Density (watts/SF)	0.83	0.80	0.02
Estimated Cost of Fixture Replacement (\$)	2,797		
Estimated Cost of Controls Improvements (\$)	6,600		
Total Consumption Cost Savings (\$)	2,882		

Legend:				
Fixture Type	Lamp Type	Control Type	Ballast Type	Retrofit Category
Exit Sign	LED	N (None)	N/A (None)	N/A (None)
Screw-in	Inc (Incandescent)	S (Switch)	E (Electronic)	T8 (Install new T8)
Pin	1T5	OS (Occupancy Sensor)	M (Magnetic)	T5 (Install new T5)
Parabolic	2T5	T (Timer)		CFL (Install new CFL)
Recessed	3T5	PC (Photocell)		LEDex (Install new LED Exit)
2U-shape	4T5	D (Dimming)		LED (Install new LED)
Circiline	2T8	DL (Daylight Sensor)		D (Delamping)
Exterior	3T8	M (Microphonic Sensor)		C (Controls Only)
HID (High Intensity Discharge)	4T8			
	6T8			
	8T8			
	2T12			
	3T12			
	4T12			
	6T12			
	8T12			
	CFL (Compact Fluorescent Lightbulb)			
	MR16			
	Halogen			
	MV (Mercury Vapor)			
	MH (Metal Halide)			
	HPS (High Pressure Sodium)			
	LPS (Low Pressure Sodium)			

Location			Existing Fixture Information											Retrofit Information											Annual Savings						
Marker	Floor	Room Identification	Fixture Type	Ballast	Lamp Type	# of Fixtures	# of Lamps per Fixture	Watts per Lamp	Controls	Operational Hours per Day	Operational Days per Year	Ballast Wattage	Total Watts	Energy Use kWh/year	Category	Fixture Type	Lamp Type	Ballast	Controls	# of Fixtures	# of Lamps per Fixture	Watts per Lamp	Operational Hours per Day	Operational Days per Year	Ballast Watts	Total Watts	Energy Use kWh/year	Fixture Savings (kWh)	Controls Savings (kWh)	Total Savings (kWh)	
1	1	Mechanical Rm	Fluorescent	E	4T8	5	2	32	OS	4	261	5	345	360	N/A	Fluorescent	4T8	E	OS	5	2	32	4	261	5	345	360	0	0	0	
2	1	Hallway	Fluorescent	S	CFL	1	1	13	Sw	12	261	0	13	41	N/A	Fluorescent	CFL	S	Sw	1	1	13	12	261	0	13	41	0	0	0	
3	1	Hallway	Fluorescent	E	2T8	3	2	17	Sw	12	261	2	108	338	C	Fluorescent	2T8	E	MS	3	2	17	9	261	2	108	254	0	85	85	
4	1	Hallway	Fluorescent	E	4T8	4	2	32	Sw	12	261	5	276	864	C	Fluorescent	4T8	E	MS	4	2	32	9	261	5	276	648	0	216	216	
5	1	Hallway	Exit Sign	S	LED	3	1	5	N	24	365	1	17	145	N/A	Exit Sign	LED	S	N	3	1	5	24	365	1	17	145	0	0	0	
6	1	Staircase	Fluorescent	E	4T8	6	2	32	Sw	12	261	5	414	1,297	C	Fluorescent	4T8	E	MS	6	2	32	9	261	5	414	972	0	324	324	
7	1	Bathroom Women	Fluorescent	E	8 U-Sha	3	2	32	OS	9	261	5	207	486	N/A	Fluorescent	8 U-Sha	E	OS	3	2	32	9	261	5	207	486	0	0	0	
8	1	Bathroom Men	Fluorescent	E	8 U-Sha	3	2	32	OS	9	261	5	207	486	N/A	Fluorescent	8 U-Sha	E	OS	3	2	32	9	261	5	207	486	0	0	0	
9	1	Bathroom Men	Fluorescent	E	2T8	1	2	17	OS	9	261	2	36	85	N/A	Fluorescent	2T8	E	OS	1	2	17	9	261	2	36	85	0	0	0	
10	1	Bathroom Women	Fluorescent	E	2T8	1	2	17	OS	9	261	2	36	85	N/A	Fluorescent	2T8	E	OS	1	2	17	9	261	2	36	85	0	0	0	
11	1	Auditorium	Recessed Paralel	E	4T8	20	4	32	Sw	4	48	5	2,660	511	C	Recessed Paralel	4T8	E	OS	20	4	32	3	48	5	2,660	383	0	128	128	
12	1	Auditorium	Recessed	S	Inc	7	1	90	D	2	48	0	630	60	CFL	Recessed	CFL	S	D	7	1	30	2	48	0	210	20	40	0	40	40
13	1	Auditorium	Exit Sign	S	LED	3	1	5	N	24	365	1	17	145	N/A	Exit Sign	LED	S	N	3	1	5	24	365	1	17	145	0	0	0	
14	1	Closet	Fluorescent	E	4T8	1	2	32	OS	1	261	5	69	18	N/A	Fluorescent	4T8	E	OS	1	2	32	1	261	5	69	18	0	0	0	
15	1	Kitchen	Fluorescent	E	4T8	6	2	32	OS	2	261	5	414	216	N/A	Fluorescent	4T8	E	OS	6	2	32	2	261	5	414	216	0	0	0	
16	1	Staircase	Fluorescent	E	4T8	4	2	32	Sw	16	261	5	276	1,153	C	Fluorescent	4T8	E	MS	4	2	32	12	261	5	276	864	0	288	288	
17	1	Staircase	Fluorescent	S	CFL	2	1	13	Sw	16	261	0	26	109	N/A	Fluorescent	CFL	S	Sw	2	1	13	16	261	0	26	109	0	0	0	
18	1	Staircase	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sign	LED	S	N	1	1	5	24	365	1	6	48	0	0	0	
19	2	Hallway	Recessed Paralel	E	8 U-Sha	3	2	32	Sw	12	261	5	207	648	C	Recessed Paralel	8 U-Sha	E	MS	3	2	32	9	261	5	207	486	0	162	162	
20	2	Hallway	Recessed Paralel	E	4T8	2	4	32	Sw	12	261	5	266	833	C	Recessed Paralel	4T8	E	MS	2	4	32	9	261	5	266	625	0	208	208	
21	2	Hallway	Exit Sign	S	LED	2	1	5	N	24	365	1	11	96	N/A	Exit Sign	LED	S	N	2	1	5	24	365	1	11	96	0	0	0	
22	2	Registrar office	Recessed Paralel	E	4T8	2	4	32	Sw	9	261	5	266	625	C	Recessed Paralel	4T8	E	OS	2	4	32	7	261	5	266	469	0	156	156	
23	2	Registrar office	Recessed Paralel	E	4T8	6	4	32	Sw	9	261	5	798	1,875	C	Recessed Paralel	4T8	E	OS	6	4	32	7	261	5	798	1,406	0	469	469	
24	2	Staircase	Fluorescent	S	CFL	2	1	13	Sw	16	261	0	26	109	N/A	Fluorescent	CFL	S	Sw	2	1	13	16	261	0	26	109	0	0	0	
25	2	Staircase	Fluorescent	S	CFL	1	1	35	Sw	16	261	0	35	146	N/A	Fluorescent	CFL	S	Sw	1	1	35	16	261	0	35	146	0	0	0	
26	2	Staircase	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sign	LED	S	N	1	1	5	24	365	1	6	48	0	0	0	
27	2	Town clerks office	Recessed Paralel	E	4T8	8	4	32	Sw	9	261	5	1,064	2,499	C	Recessed Paralel	4T8	E	OS	8	4	32	7	261	5	1,064	1,875	0	625	625	
28	2	File rm	Fluorescent	E	4T8	6	4	32	Sw	9	261	5	798	1,875	C	Fluorescent	4T8	E	OS	6	4	32	7	261	5	798	1,406	0	469	469	
29	2	Hallway	Recessed Paralel	E	4T8	3	2	32	Sw	16	261	5	207	864	C	Recessed Paralel	4T8	E	MS	3	2	32	12	261	5	207	648	0	216	216	
30	2	Hallway	Exit Sign	S	LED	1	1	5	N	24	365	1	6	48	N/A	Exit Sign	LED	S	N	1	1	5	24	365	1	6	48	0	0	0	
31	2	Bathroom Women	Recessed Paralel	E	4T8	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	4T8	E	OS	1	2	32	9	261	5	69	162	0	0	0	
32	2	Bathroom Men	Recessed Paralel	E	4T8	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	4T8	E	OS	1	2	32	9	261	5	69	162	0	0	0	
33	2	Bathroom Men	Recessed Paralel	E	8 U-Sha	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	8 U-Sha	E	OS	1	2	32	9	261	5	69	162	0	0	0	
34	2	Bathroom Women	Recessed Paralel	E	8 U-Sha	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	8 U-Sha	E	OS	1	2	32	9	261	5	69	162	0	0	0	
35	2	Bathroom Women	Vall Mounte	E	2T8	1	2	17	OS	9	261	2	36	85	N/A	Vall Mounte	2T8	E	OS	1	2	17	9	261	2	36	85	0	0	0	
36	2	Bathroom Men	Vall Mounte	E	2T8	1	2	17	OS	9	261	2	36	85	N/A	Vall Mounte	2T8	E	OS	1	2	17	9	261	2	36	85	0	0	0	
37	2	Office	Recessed Paralel	E	4T8	2	2	32	Sw	9	261	5	138	324	C	Recessed Paralel	4T8	E	OS	2	2	32	7	261	5	138	243	0	81	81	
38	2	Office	Spotlight	S	Inc	1	3	60	D	9	261	0	180	423	CFL	Spotlight	CFL	S	D	1	3	20	9	261	0	60	141	282	0	282	282
39	2	Hallway	Recessed Paralel	E	4T8	1	3	32	Sw	16	261	5	101	422	C	Recessed Paralel	4T8	E	MS	1	3	32	12	261	5	101	316	0	105	105	
40	2	Office	Recessed Paralel	E	4T8	1	2	32	Sw	9	261	5	69	162	N/A	Recessed Paralel	4T8	E	Sw	1	2	32	9	261	5	69	162	0	0	0	
41	3	Office	Fluorescent	E	4T8	4	4	32	Sw	9	261	5	532	1,250	C	Fluorescent	4T8	E	OS	4	4	32	7	261	5	532	937	0	312	312	
42	3	closet	Vall Mounte	S	Inc	1	1	60	Sw	1	261	0	60	16	CFL	Vall Mounte	CFL	S	Sw	1	1	20	1	261	0	20	5	10	0	10	10
43	3	Hallway	Recessed Paralel	E	4T8	6	4	32	Sw	16	261	5	798	3,332	C	Recessed Paralel	4T8	E	MS	6	4	32	12	261	5	798	2,499	0	833	833	
44	3	Hallway	Recessed Paralel	E	4T8	8	2	32	Sw	16	261	5	552	2,305	C	Recessed Paralel	4T8	E	MS	8	2	32	12	261	5	552	1,729	0	576	576	
45	3	Meeting Rm B	Recessed Paralel	E	4T8	3	4	32	Sw	9	261	5	399	937	C	Recessed Paralel	4T8	E	OS	3	4	32	7	261	5	399	703	0	234	234	
46	3	Tax Collector office	Recessed Paralel	E	4T8	6	4	32	Sw	9	261	5	798	1,875	C	Recessed Paralel	4T8	E	OS	6	4	32	7	261	5	798	1,406	0	469	469	
47	3	Assessor office	Recessed Paralel	E	4T8	6	4	32	Sw	9	261	5	798	1,875	C	Recessed Paralel	4T8	E	OS	6	4	32	7	261	5	798	1,406	0	469	469	
48	2	Bathroom Women	Recessed Paralel	E	4T8	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	4T8	E	OS	1	2	32	9	261	5	69	162	0	0	0	
49	2	Bathroom Men	Recessed Paralel	E	4T8	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	4T8	E	OS	1	2	32	9	261	5	69	162	0	0	0	
50	2	Bathroom Men	Recessed Paralel	E	8 U-Sha	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	8 U-Sha	E	OS	1	2	32	9	261	5	69	162	0	0	0	
51	2	Bathroom Women	Recessed Paralel	E	8 U-Sha	1	2	32	OS	9	261	5	69	162	N/A	Recessed Paralel	8 U-Sha	E	OS	1	2	32	9	261	5	69	162	0	0	0	
52	2	Bathroom Women	Vall Mounte	E	2T8	1	2	17	OS	9	261	2	36	85	N/A	Vall Mounte	2T8	E	OS	1	2	17	9	261	2	36	85	0	0	0	
53	2	Bathroom Men	Vall Mounte	E	2T8	1	2	17	OS	9	261	2	36	85	N/A	Vall Mounte	2T8	E	OS	1	2	17	9	261	2	36	85	0	0	0	
54	3	Bldgs Health Dept	Recessed Paralel	E	4T8	3	4	32	Sw	9	261	5	399	937	C	Recessed Paralel	4T8	E	OS	3	4	32	7	261	5	399	703	0	234	234	
55	3	Bldgs Health Dept office	Recessed Paralel	E	4T8	5	4	32	Sw	9	261	5	665	1,562	C	Recessed Paralel	4T8	E	OS	5											

APPENDIX C: THIRD PARTY ENERGY SUPPLIERS

A list of licensed electrical suppliers and aggregators can be found on the Connecticut Department of Public Utility Control Website at:

<http://www.ct.gov/dpuc/cwp/view.asp?a=3356&q=414004>

Information on fuel oil retailers can be found through the Independent Connecticut Petroleum Association and Education Foundation at:

<http://www.icpa.org/find.htm>

APPENDIX D: GLOSSARY AND METHOD OF CALCULATIONS

Net ECM Cost: The net ECM cost is the cost experienced by the customer, which is typically the total cost (materials + labor) of installing the measure minus any available incentives. Both the total cost and the incentive amounts are expressed in the summary for each ECM.

Annual Energy Cost Savings (AECS): Value determined by the auditor based on calculated energy savings (kWh or Therms) of each ECM and the calculated energy costs of the building.

Lifetime Energy Cost Savings (LECS): This measure estimates the energy cost savings over the lifetime of the ECM. It can be a simple estimation based on fixed energy costs. If desired, this value can factor in an annual increase in energy costs as long as the source is provided.

Simple Payback: This is a simple measure that displays how long the ECM will take to break-even based on the annual energy and maintenance savings of the measure.

ECM Lifetime: This is included with each ECM so that the owner can see how long the ECM will be in place and whether or not it will exceed the simple payback period. Additional guidance for calculating ECM lifetimes can be found below. This value can come from manufacturer's rated lifetime or warranty, the ASHRAE rated lifetime, or any other valid source.

Operating Cost Savings (OCS): This calculation is an annual operating savings for the ECM. It is the difference in operating, maintenance, and/or equipment replacement costs of the existing case versus the ECM. In the case where an ECM lifetime will be longer than the existing measure (such as LED lighting versus fluorescent) the operating savings will factor in the cost of replacing the units to match the lifetime of the ECM. In this case or in one where one-time repairs are made, the total replacement / repair sum is averaged over the lifetime of the ECM.

Return on Investment (ROI): The ROI is expressed as the percentage return of the investment based on the lifetime cost savings of the ECM. This value can be included as an annual or lifetime value, or both.

Net Present Value (NPV): The NPV calculates the present value of an investment's future cash flows based on the time value of money, which is accounted for by a discount rate (assumes bond rate of 3.2%).

Internal Rate of Return (IRR): The IRR expresses an annual rate that results in a break-even point for the investment. If the owner is currently experiencing a lower return on their capital than the IRR, the project is financially advantageous. This measure also allows the owner to compare ECMs against each other to determine the most appealing choices.

Gas Rate and Electric Rate (\$/therm and \$/kWh): The gas rate and electric rate used in the financial analysis is the total annual energy cost divided by the total annual energy usage for the 12 month billing period studied. The graphs of the monthly gas and electric rates reflect the total monthly energy costs divided by the monthly usage, and display how the average rate fluctuates throughout the year. The average annual rate is the only rate used in energy savings calculations.

Calculation References

Term	Definition
ECM	Energy Conservation Measure
AOCS	Annual Operating Cost Savings
AECS	Annual Energy Cost Savings
LOCS*	Lifetime Operating Cost Savings
LECS	Lifetime Energy Cost Savings
LCS	Lifetime Cost Savings
NPV	Net Present Value
IRR	Internal Rate of Return
DR	Discount Rate
Net ECM Cost	Total ECM Cost – Incentive
LECS	AECS X ECM Lifetime
AOCS	LOCS / ECM Lifetime
LCS	LOCS+LECS
Simple Payback	Net ECM Cost / (AECS + AOCS)
Lifetime ROI	(LECS + LOCS – Net ECM Cost) / Net ECM Cost
Annual ROI	(Lifetime ROI / Lifetime) = [(AECS + OCS) / Net ECM Cost – (1 / Lifetime)]

* The lifetime operating cost savings are all avoided operating, maintenance, and/or component replacement costs over the lifetime of the ECM. This can be the sum of any annual operating savings, recurring or bulk (i.e. one-time repairs) maintenance savings, or the savings that comes from avoiding equipment replacement needed for the existing measure to meet the lifetime of the ECM (e.g. lighting change outs).

Excel NPV and IRR Calculation

In Excel, function =IRR (values) and =NPV(rate, values) are used to quickly calculate the IRR and NPV of a series of annual cash flows. The investment cost will typically be a negative cash flow at year 0 (total cost - incentive) with years 1 through the lifetime receiving a positive cash flow from the annual energy cost savings and annual maintenance savings. The calculations in the example below are for an ECM that saves \$850 annually in energy and maintenance costs (over a 10 year lifetime) and takes \$5,000 to purchase and install after incentives:

	A	B	C	D	E	F	G	H	I
1									
2									
3									
4					Year	Cash Flow			
5					0	\$ (5,000.00)			Investment Cost
6					1	\$ 850.00			
7					2	\$ 850.00			
8					3	\$ 850.00			
9					4	\$ 850.00			
10					5	\$ 850.00			
11					6	\$ 850.00			
12					7	\$ 850.00			
13					8	\$ 850.00			
14					9	\$ 850.00			
15					10	\$ 850.00			
16					IRR	11.03%			
17					NPV	\$2,250.67			

ECM Lifetime: 10 years (rows 5-14)

Cash Flow: Annual Energy Cost Savings + Annual Maintenance Savings

Formula:
 =IRR(F4:F14)
 =NPV(0.03,F5:F14)+F4

Solar PV ECM Calculation

There are several components to the calculation:

Costs:	Material of PV system including panels, mounting and net-metering + Labor
Energy Savings:	Reduction of kWh electric cost for life of panel, 25 years
Incentive 1:	Typically, Renewable Energy Incentive Programs (REIP) offer an incentive amount per Watt for systems 50 kW or less. SWA did not find program information applicable in CT.
Incentive 2:	Solar Renewable Energy Credits (SRECs) – These are market-rate incentives. Calculations typically assume \$600/Megawatt hour consumed per year for a maximum of 15 years; added to annual energy cost savings for a period of 15 years. (Megawatt hour used is rounded to nearest 1,000 kWh). SWA did not apply this incentive in this analysis.
Assumptions:	A Solar Pathfinder device is typically used to analyze site shading for the building and determine maximum amount of full load operation based on available sunlight. For this project, the roof is fairly unshaded and Solar Pathfinder was not required. PV Watts software was used for the analysis.

Total lifetime PV energy cost savings =
kWh produced by panel * [\$/kWh cost * 25 years + \$600/Megawatt hour /1000 * 15 years]

ECM and Equipment Lifetimes

Determining a lifetime for equipment and ECM's can sometimes be difficult. The following table contains a list of lifetimes that SWA uses to support recommendations for a number of commercial and industrial programs. Other valid sources are also used to determine lifetimes, such as the DOE, ASHRAE, or the manufacturer's warranty.

Lighting is typically the most difficult lifetime to calculate because the fixture, ballast, and bulb can all have different lifetimes. Essentially the ECM analysis will have different operating cost savings (avoided equipment replacement) depending on which lifetime is used.

When the bulb lifetime is used (rated burn hours / annual burn hours), the operating cost savings is just reflecting the theoretical cost of replacing the existing case bulb and ballast over the life of the recommended bulb. Dividing by the bulb lifetime will give an annual operating cost savings.

When a fixture lifetime is used (e.g. 15 years) the operating cost savings reflects the avoided bulb and ballast replacement cost of the existing case over 15 years minus the projected bulb and ballast replacement cost of the proposed case over 15 years. This will give the difference of the equipment replacement costs between the proposed and existing cases and when divided by 15 years will give the annual operating cost savings.

Typical Commercial & Industrial Equipment Lifetimes

Measure	Life Span
Commercial Lighting — New	15
Commercial Lighting — Remodel/Replacement	15
Commercial Custom — New	18
Commercial Chiller Optimization	18
Commercial Unitary HVAC — New - Tier 1	15
Commercial Unitary HVAC — Replacement - Tier 1	15
Commercial Unitary HVAC — New - Tier 2	15
Commercial Unitary HVAC — Replacement Tier 2	15
Commercial Chillers — New	25
Commercial Chillers — Replacement	25
Commercial Small Motors (1-10 HP) — New or Replacement	20
Commercial Medium Motors (11-75 HP) — New or Replacement	20
Commercial Large Motors (76-200 HP) — New or Replacement	20
Commercial VSDs — New	15
Commercial VSDs — Retrofit	15
Commercial Comprehensive New Construction Design	18
Commercial Custom — Replacement	18
Industrial Lighting — New	15
Industrial Lighting — Remodel/Replacement	15
Industrial Unitary HVAC — New - Tier 1	15
Industrial Unitary HVAC — Replacement - Tier 1	15
Industrial Unitary HVAC — New - Tier 2	15
Industrial Unitary HVAC — Replacement Tier 2	15
Industrial Chillers — New	25
Industrial Chillers — Replacement	25
Industrial Small Motors (1-10 HP) — New or Replacement	20
Industrial Medium Motors (11-75 HP) — New or Replacement	20
Industrial Large Motors (76-200 HP) — New or Replacement	20
Industrial VSDs — New	15
Industrial VSDs — Retrofit	15
Industrial Custom — Non-Process	18
Industrial Custom — Process	10
Small Commercial Gas Furnace — New or Replacement	20
Small Commercial Gas Boiler — New or Replacement	20
Small Commercial Gas DHW — New or Replacement	10
C&I Gas Absorption Chiller — New or Replacement	25
C&I Gas Custom — New or Replacement (Engine Driven Chiller)	25
C&I Gas Custom — New or Replacement (Gas Efficiency Measures)	18
O&M savings	3
Compressed Air (GWh participant)	8

APPENDIX E: STATEMENT OF ENERGY PERFORMANCE FROM ENERGY STAR®

OMB No. 2060-0347



STATEMENT OF ENERGY PERFORMANCE Town of Essex - Town Hall

Building ID: 2312001
For 12-month Period Ending: August 31, 2009¹
Date SEP becomes ineligible: N/A

Date SEP Generated: June 03, 2010

Facility
Town of Essex - Town Hall
29 West Ave
Essex, CT 06426

Facility Owner
N/A

Primary Contact for this Facility
N/A

Year Built: 1892
Gross Floor Area (ft²): 24,000

Energy Performance Rating² (1-100): N/A

Site Energy Use Summary³

Electricity - Grid Purchase (kBtu)	473,638
Fuel Oil (No. 2) (kBtu)	968,621
Natural Gas - (kBtu) ⁴	0
Total Energy (kBtu)	1,442,259

Energy Intensity⁵

Site (kBtu/ft²/yr)	70
Source (kBtu/ft²/yr)	107

Emissions (based on site energy use)

Greenhouse Gas Emissions (MtCO ₂ e/year)	130
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Electric Distribution Utility

Northeast Util - Connecticut Light & Power Co

National Average Comparison

National Average Site EUI	104
National Average Source EUI	213
% Difference from National Average Source EUI	-50%
Building Type	Other

Stamp of Certifying Professional

Based on the conditions observed at the time of my visit to this building, I certify that the information contained within this statement is accurate.

Meets Industry Standards⁶ for Indoor Environmental Conditions:

Ventilation for Acceptable Indoor Air Quality	N/A
Acceptable Thermal Environmental Conditions	N/A
Adequate Illumination	N/A

Certifying Professional
N/A

Notes:

1. Application for the ENERGY STAR must be submitted to EPA within 4 months of the Period Ending date. Award of the ENERGY STAR is not final until approval is received from EPA.
2. The EPA Energy Performance Rating is based on total source energy. A rating of 75 is the minimum to be eligible for the ENERGY STAR.
3. Values represent energy consumption, annualized to a 12-month period.
4. Natural Gas values in this report (e.g., cubic feet) are converted to kBtu with adjustments made for elevation based on Facility zip code.
5. Values represent energy intensity, annualized to a 12-month period.
6. Based on Meeting ASHRAE Standard 62 for ventilation for acceptable indoor air quality, ASHRAE Standard 55 for thermal comfort, and IESNA Lighting Handbook for lighting quality.

The government estimates the average time needed to fill out this form is 6 hours (includes the time for entering energy data, PE facility inspection, and notarizing the SEP) and we welcome suggestions for reducing this burden. Send comments (including OMB control number) to the Director, Collection Strategies Division, U.S. EPA (2622), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460.

EPA Form 5900-16

APPENDIX F: INCENTIVE PROGRAMS

Commercial and Industrial Rebate Program (CEEIP)

Connecticut electricity customers that install energy efficiency equipment and reduce their energy use during peak hours may be eligible for a rebate based on the amount of kilowatt-hours (kWh) saved during peak hours. Any customer, whether building a new facility or retrofitting an existing facility that is located in Connecticut, is eligible to apply. The key consideration for qualifying is that the customer's proposed energy efficient retrofits and/or new building plans must result in energy savings during the winter peak (5 pm and 7 pm in December and January) and summer peak (1 pm and 5 pm in June, July, and August).

Examples of energy efficient technologies that could qualify include: lighting and lighting controls, HVAC systems, refrigeration, motors and variable frequency drives (VFD's), and energy efficient improvements to overall manufacturing processes or data centers.

Businesses, non-profit organizations, and government facilities are eligible. Ideal customers include: retail facilities, 2-shift manufacturing/industrial facilities, parking garages, hospitals, and other facilities with long hours of operation.

For more information, please contact:

Larry Kata, Ameresco

Phone: (866) 314-9611

Email: lkata@ameresco.com

Web: <http://www.ameresco.com/ctdsmEEP>

Community Innovations Grant Program (CCEF)

Connecticut electricity customers that install energy efficiency equipment and reduce their energy use during peak hours may be eligible for a rebate based on the amount of kilowatt-

The Community Innovations Grants Program, originally launched in June 2006 as a pilot program, provides funding for communities to increase voluntary support for clean energy and to build model sustainable communities. Through new funding made available in December 2008, up to 50 municipalities are eligible to receive a micro-grant of \$4,000 and up to 45 municipalities are eligible to receive a micro-grant of \$2,000. Cities or towns must commit to the state's "20% by 2010 Campaign" and the EPA Community Energy Challenge. Municipalities that have previously received a Community Innovations Grant are not eligible for this grant.

Block grants are awarded to eligible communities, and the funds are managed by a local energy task force in each participating community. In turn, these energy task forces, through a grant-giving process, provide micro-grants to organizations and citizens to start local projects that support clean-energy awareness and education within their communities. Applicants for individual micro-grants may apply to the local energy task force for funds ranging from \$250 to \$2,000 to support a public-awareness project or education project addressing the benefits and availability of clean energy. This program is supported by the Connecticut Clean Energy Fund.

For more information, please contact:

Bob Wall, Connecticut Clean Energy Fund

Phone: (860) 563-5851 Ext.354

E-Mail: bob.wall@ctinnovations.com

Web: <http://www.ctcleanenergy.com>

On-Site Renewable Distributed Generation Program (CCEF)

Connecticut's On-Site Renewable Distributed Generation (DG) Program provides grants to support the installation of systems that generate electricity at commercial, industrial and institutional buildings. Systems utilizing solar photovoltaics (PV), wind, fuel cells, landfill gas, low-emission advanced biomass-conversion technologies, run-of-the-river hydropower, wave or tidal power, or ocean-thermal power are eligible.* Most program support will target PV and fuel-cell projects. Projects that have potential to reduce the federally mandated congestion charges in Connecticut will be favored. This program is supported by the Connecticut Clean Energy Fund (CCEF), which, after exceeding -- by four megawatts (MW) -- its objective of incenting the installation of 5 MW of customer-side DG projects by mid-2007, has committed to adding 16.5 MW to Connecticut's renewable generating capacity by 2010.

Note: As of Jan 15, 2009, the On-Site Renewable DG Program is NOT accepting PV applications. Applications received prior to that date will be reviewed and awarded until budget allocations are fully committed. For this reason, no PV incentives were used in the cost analysis in this report.

For more information, please contact:

Christin Cifaldi, Connecticut Clean Energy Fund

Phone: (860) 563-5851

Web: <http://www.ctcleanenergy.com/default.aspx?tabid=95>

Sales and Use Tax Exemption for Solar and Geothermal Systems

Connecticut enacted legislation in June 2007 (H.B. 7432) that established a sales and use tax exemption for solar energy equipment and geothermal resource systems. H.B. 7432 added passive and active solar water-heating systems, passive and active solar space-heating systems, and solar-electric systems to the list of exempt technologies. The sales and use exemption covers both the equipment related to eligible systems and labor (services) relating to the installation of eligible systems. The exemption has no expiration date.

For more information, please contact:

Connecticut Department of Revenue Services

Phone: (860) 297-5962

Web: <http://www.ct.gov/DRS>

Small Business Energy Advantage Program (Connecticut Light and Power)

Connecticut Light and Power (CL&P) Small Business Energy Advantage Program is a combined rebate and loan program offered to some of CL&P's business and industrial customers for making energy efficiency improvements to their facilities. Business customers with an average 12-month peak demand between 10 kW and 200 kW qualify, as well as all industrial customers within that range are eligible, CL&P prefers industrial customers with loads below 50 kW. Municipal and governmental facilities are also eligible. A contractor conducts an energy assessment of the facility and submits a proposal of possible energy-efficiency measures, estimated energy savings, customer incentives, and financing options. Once approved by CL&P, exact rebate amount is determined. In addition to the rebate, the remaining cost of the project can be paid off in the form of a zero interest loan directly from CL&P.

For more information, please contact:

Connecticut Light & Power Customer Service

Phone: (800) 286-2000

E-Mail: BusinessSolutions@nu.com

Web: <http://www.cl-p.com/business/saveenergy/services/energyadvantage...>

Small Industrial and Commercial Energy Efficiency Loan Program (CL&P)

Connecticut Light & Power (CL&P) offers the Small Industrial and Commercial Loan Program to industrial and commercial customers for the installation of electric energy-saving measures. Eligible industrial customers are those that have been in business at least three years, with a good credit history, fewer than 100 employees, and an average demand over 200 kilowatts (kW). Loans are not available for customers or projects that qualify for CL&P's Energy Conscious Blueprint or Small Business Energy Advantage programs. The loan is interest-free and has a maximum five-year payback period. The maximum loan amount is \$100,000 and the minimum is \$5,000.

For more information, please contact:

Connecticut Light & Power Customer Service

Phone: (800) 286-2000

E-Mail: BusinessSolutions@nu.com

Web: <http://www.cl-p.com/business/saveenergy/financing/smallciloans.as...>

Commercial Energy Efficiency Rebates (CL&P)

Connecticut Light & Power (CL&P) offers rebates for certain energy-efficiency equipment purchased by the utility's commercial and industrial customers. Rebates are available for retrofits of energy-efficiency HVAC equipment, lighting, motors, and vending machines. The rebates have fixed amounts, are provided on a per-unit basis, vary by the type of efficiency measure, and are paid directly to customers after they install pre-designated measures using qualified, licensed contractors. Funding for these programs is limited, and rebates are available on a first-come, first-served basis.

For more information, please contact:

Connecticut Light & Power Customer Service

Phone: (800) 286-2000

E-Mail: BusinessSolutions@nu.com

Web: <http://www.cl-p.com/Business/SaveEnergy/BusinessRebates.aspx>

Utility Sponsored Programs

Check with your local utility companies for further opportunities that may be available.

Energy Efficiency and Conservation Block Grant Rebate Program

States may be eligible for additional Energy Efficiency and Conservation Block Grant (EECBG) funding, provided through the American Recovery and Reinvestment Act (ARRA). For the most up to date information on how to participate in this program, contact the state energy office.

Other Federal and State Sponsored Programs

Other federal and state sponsored funding opportunities may be available, including renewable energy tax credits, loan programs, and grant funding. For more information, please check <http://www.dsireusa.org/>.

APPENDIX G: ENERGY CONSERVATION MEASURES

Please note: For the measures proposed, the project may be eligible for incentives through CL&P. The incentives may be prorated based on the heating fuel. To be conservative, no incentives were assumed in this analysis. As a result, the Annual Return on Investment values shown in the tables throughout this report are fractional numbers and appear as zeros. SWA suggests that the Town contact their electrical account manager at CL&P to request that this report be submitted to the appropriate CL&P representative for review and verification of any potential incentives for which the project may qualify.

Definitions:

SPP: Simple Payback (years)
LoM: Life of Measure (years)
ROI: Return on Investment (%)

Assumptions:

Discount rate = 3.2% per DOE FEMP guidelines
Energy price escalation rate = 0% per DOE FEMP guidelines

Average Electric Rate = **0.186** \$/kWh
Average Fuel Rate = **2.500** \$/gallon

Carbon Dioxide per unit Electricity = 1.7905 lbs of CO2/kWh
Carbon Dioxide per unit of Oil = 22.384 lbs of CO2/unit fuel

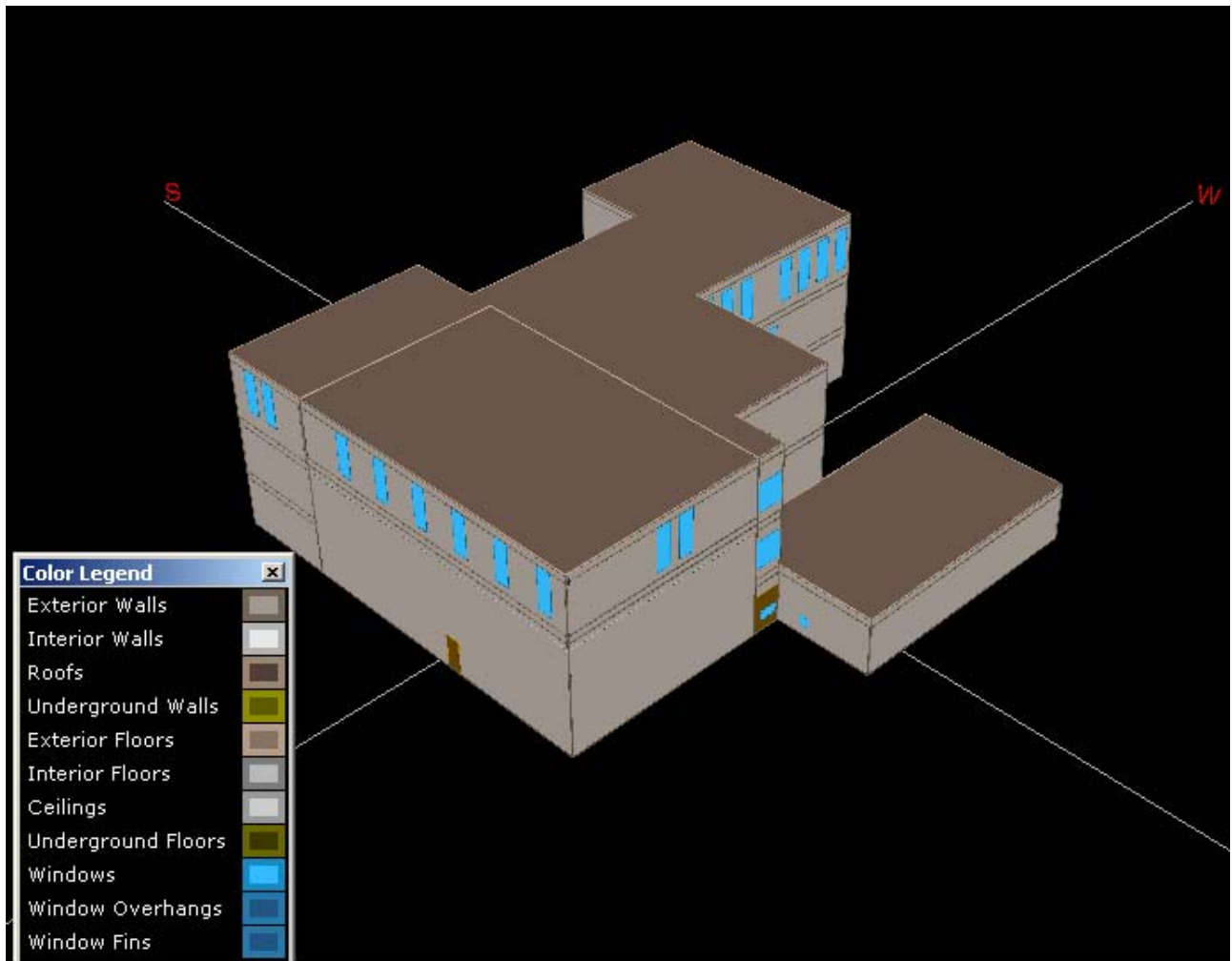
A 0.0 electrical demand reduction/month indicates that it is very low/negligible

Total building area 24,000 sq. ft

Energy Conservation Measures

ECM #	ECM description	Cost Source	Est. installed cost, \$	Est. incentives, \$	Net est. cost with incentives, \$	kWh, 1st year savings	kW, demand reduction	gallons, 1st year savings	kBtu/sq ft, 1st year savings	Est. operating cost, 1st year savings, \$	Total 1st year savings, \$	Life of measure, years	Est. lifetime energy cost savings, \$	Simple payback, years	Lifetime return-on-investment, %	Annual return-on-investment, %	Internal rate of return, %	Net present value, \$	CO ₂ reduced, lbs/year
1	Lighting Upgrades	RS Means	9,397	0	9,397	12,653	0.0	0	1.8	0	2,353	15	35,302	4.0	3	0	0	18,296	22,655
2	Boiler Outdoor Reset Controls	RS Means	5,000	0	5,000	0	0.0	362	2.1	0	906	10	9,058	5.5	1	0	0	5,658	8,110
3	Ceiling Insulation and Air Sealing	RS Means	5,000	0	5,000	0	0.0	169	1.0	0	423	15	6,345	11.8	0	0	0	-23	3,787
4	Install Vending Miser	usatech.com	430	0	430	2,536	0.0		0.4	0	472	12	5,660	0.9	12	1	1	5,120	4,541
5	Window Replacement	RS Means	103,219	0	103,219	0	0.0	1,135	6.6	0	2,838	20	56,750	36.4	0	0	N/A	-69,830	25,406
6	Install 20 kW Photovoltaic System	PV Watts	140,000	0	140,000	23,900	20.0		3.4	0	4,445	25	111,135	31.5	0	0	N/A	-87,691	42,793
	TOTALS		263,046	0	263,046	39,089	20.0	1,667	15.3	0	11,437	-	224,250	23.0	-	-	-	-128,468	107,292

APPENDIX H: eQUEST Energy Modeling Information



APPENDIX I: METHOD OF ANALYSIS

Assumptions and tools

Energy modeling tool: Established/standard industry assumptions
Cost estimates: eQUEST V3.63 and spreadsheet-based calculation methods
RS Means 2009 (Facilities Maintenance & Repair Cost Data)
RS Means 2009 (Building Construction Cost Data)
RS Means 2009 (Mechanical Cost Data)
Published and established specialized equipment material and labor costs
Note: Cost estimates are also based on utility bill analysis and prior experience with similar projects.

Disclaimer

This engineering audit was prepared using the most current and accurate fuel consumption data available for the site. The estimates that it projects are intended to help guide the owner toward best energy choices. The costs and savings are subject to fluctuations in weather, variations in quality of maintenance, changes in prices of fuel, materials, and labor, and other factors. Although we cannot guarantee savings or costs, we suggest that you use this report for economic analysis of the building and as a means to estimate future cash flow.

THE RECOMMENDATIONS PRESENTED IN THIS REPORT ARE BASED ON THE RESULTS OF ANALYSIS, INSPECTION, AND PERFORMANCE TESTING OF A SAMPLE OF COMPONENTS OF THE BUILDING SITE. ALTHOUGH CODE-RELATED ISSUES MAY BE NOTED, SWA STAFF HAVE NOT COMPLETED A COMPREHENSIVE EVALUATION FOR CODE-COMPLIANCE OR HEALTH AND SAFETY ISSUES. THE OWNER(S) AND MANAGER(S) OF THE BUILDING(S) CONTAINED IN THIS REPORT ARE REMINDED THAT ANY IMPROVEMENTS SUGGESTED IN THIS SCOPE OF WORK MUST BE PERFORMED IN ACCORDANCE WITH ALL LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS THAT APPLY TO SAID WORK. PARTICULAR ATTENTION MUST BE PAID TO ANY WORK WHICH INVOLVES HEATING AND AIR MOVEMENT SYSTEMS, AND ANY WORK WHICH WILL INVOLVE THE DISTURBANCE OF PRODUCTS CONTAINING MOLD, ASBESTOS, OR LEAD.